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(54) **SPINOUS PROCESS IMPLANTS AND ASSOCIATED METHODS**

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CPC ***A61B 17/7068*** (2013.01); ***A61B 17/7053*** (2013.01); ***A61B 17/7061*** (2013.01); *A61B 17/842* (2013.01); *A61B 2017/00477* (2013.01)

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USPC 606/246–249; 623/17.12–17.16, 17.11

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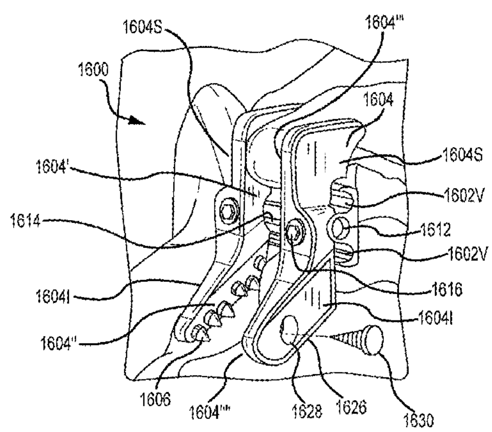
(57) **ABSTRACT**

The present invention provides spinous process implant and associated methods. In one aspect of the invention the implant limits the maximum spacing between the spinous processes. In another aspect of the invention, a spacer has at least one transverse opening to facilitate tissue in-growth. In another aspect of the invention, an implant includes a spacer and separate extensions engageable with the spacer. In another aspect of the invention, instrumentation for inserting the implant is provided. In other aspects of the invention, methods for treating spine disease are provided.

25 Claims, 26 Drawing Sheets



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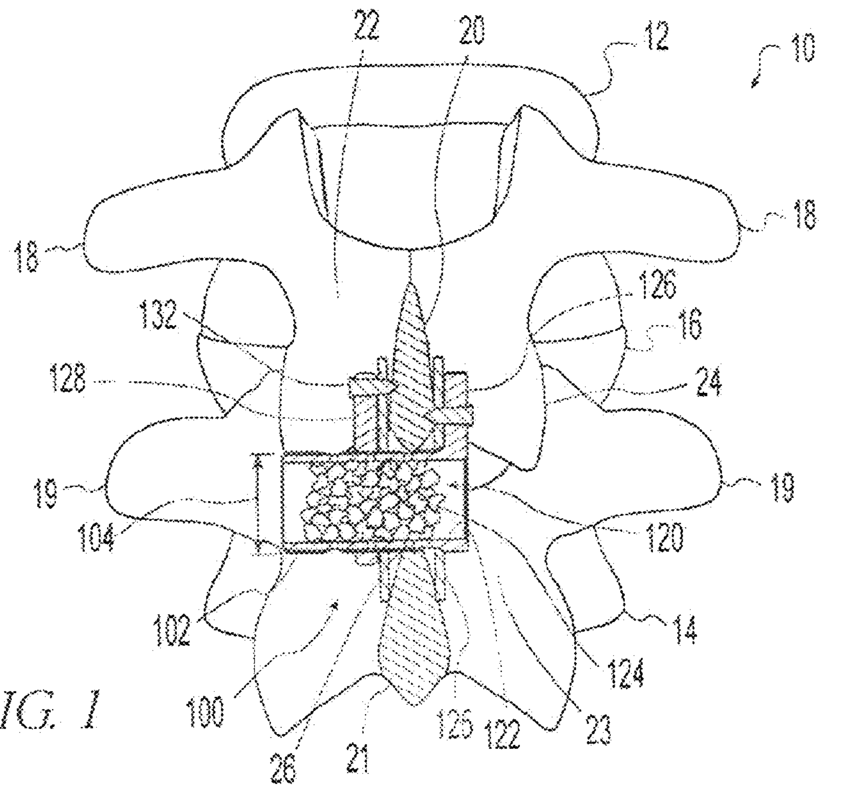
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FIG. 1

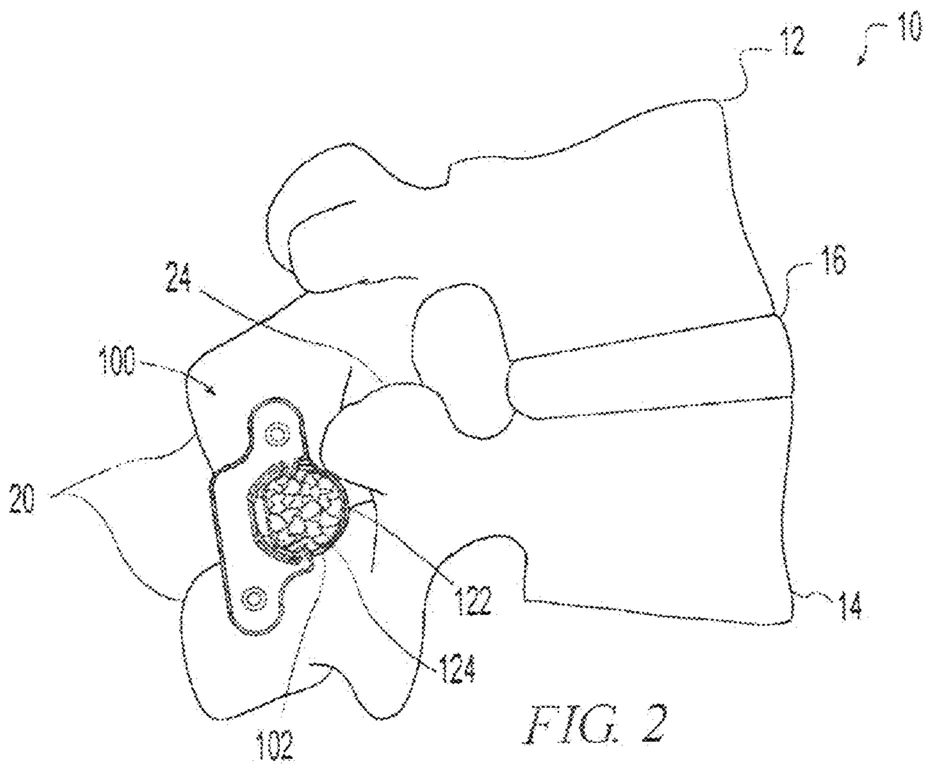
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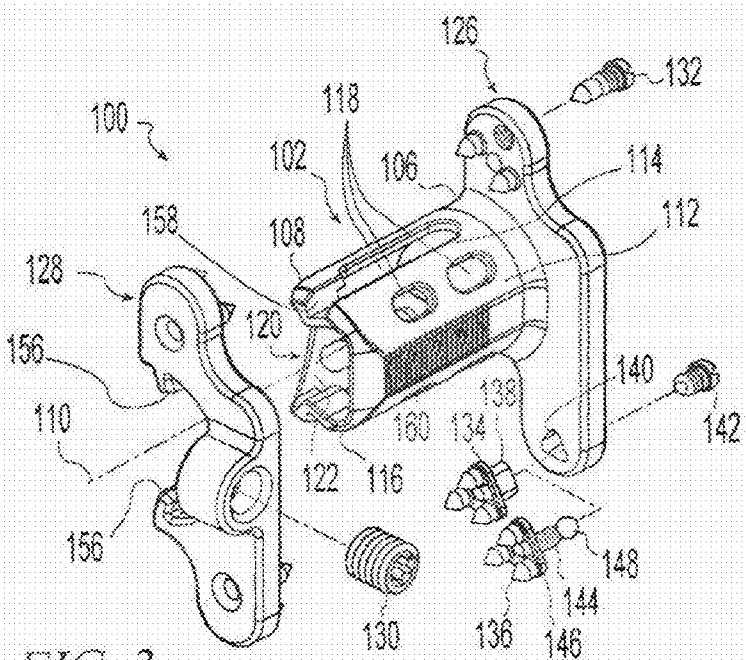
FIG. 2



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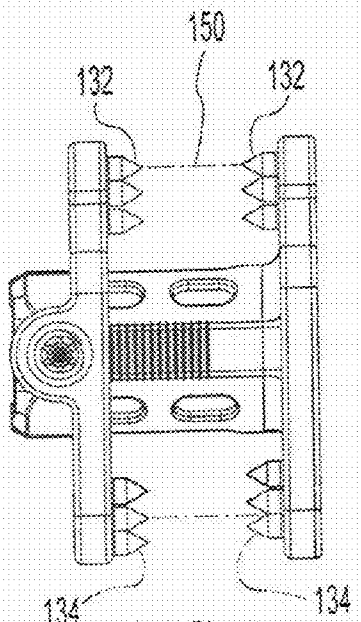

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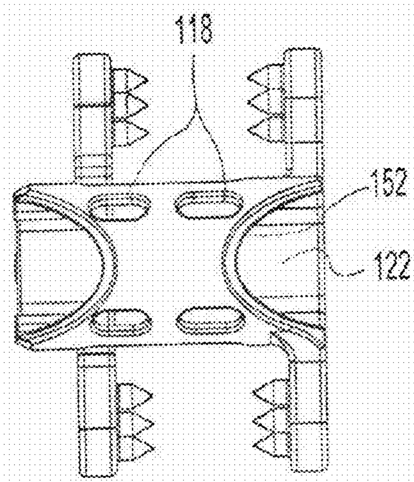


FIG. 5

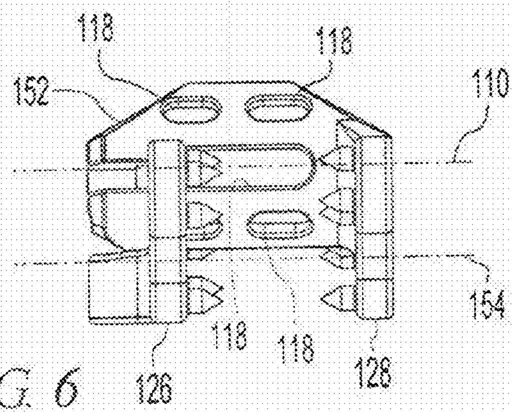


FIG. 6

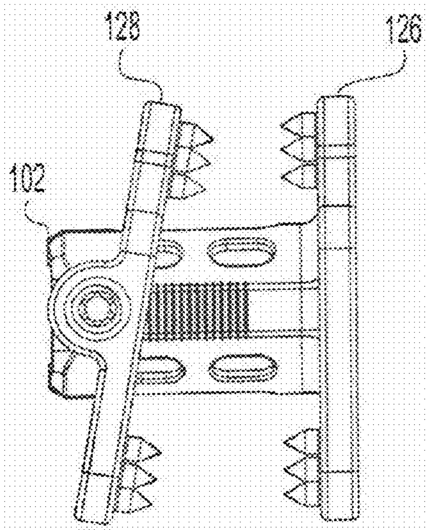


FIG. 7

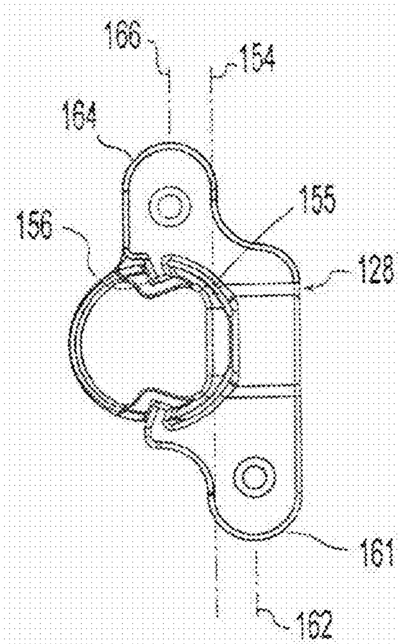


FIG. 8

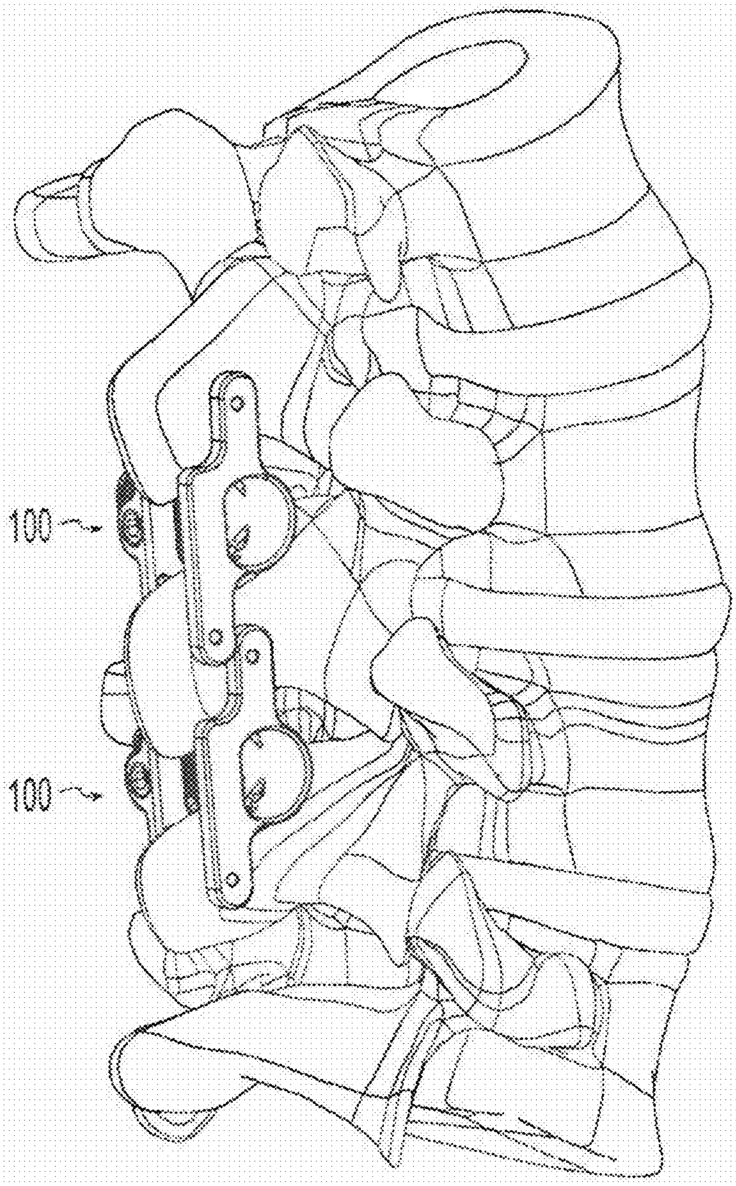


FIG. 9

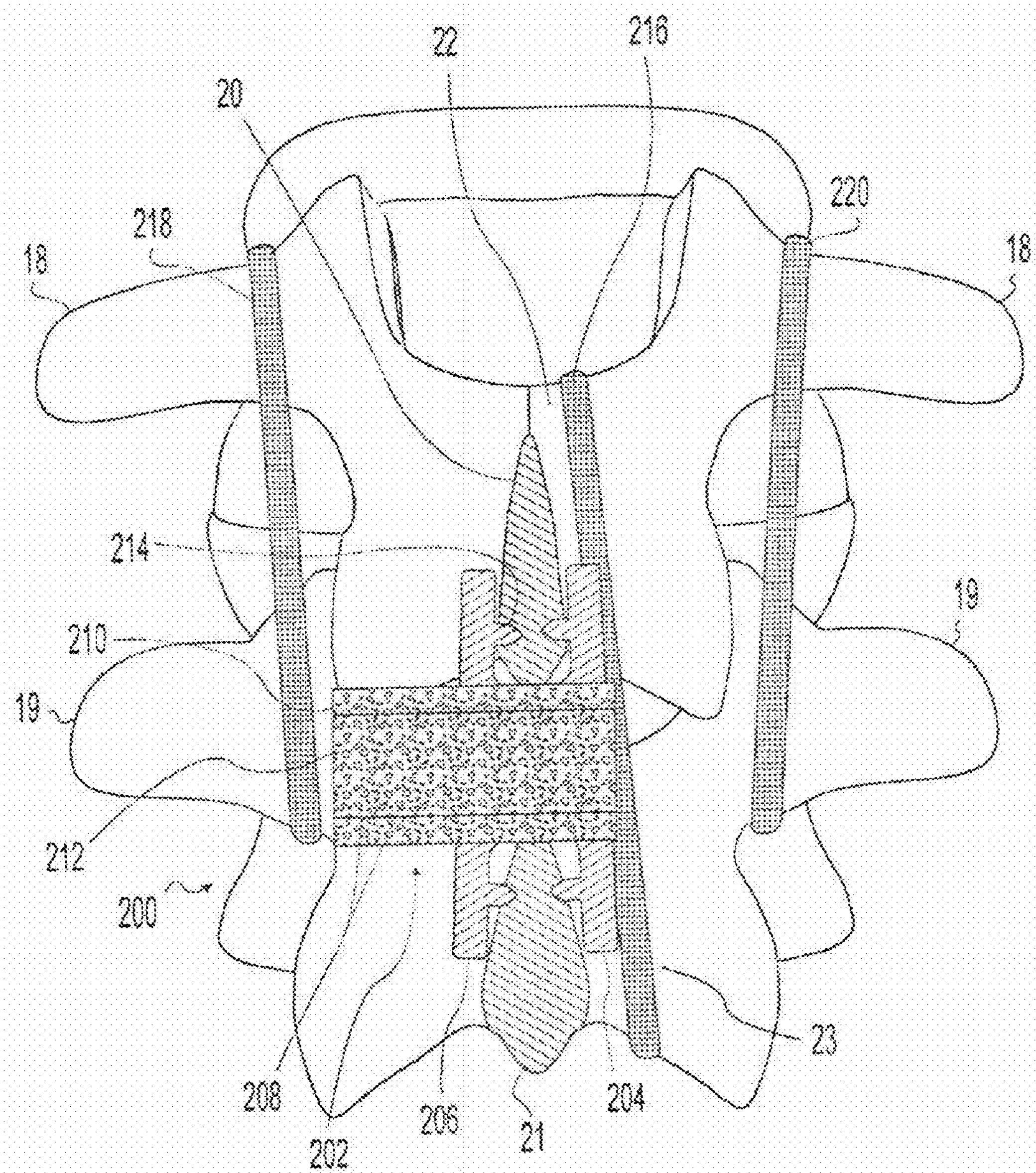


FIG. 10

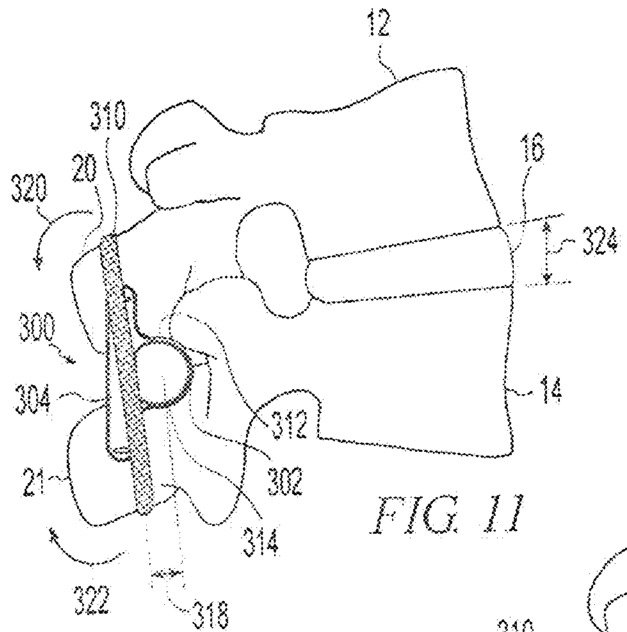
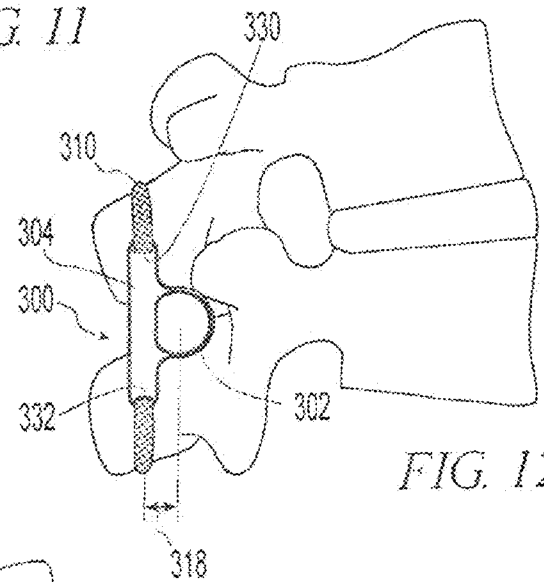


FIG. 11



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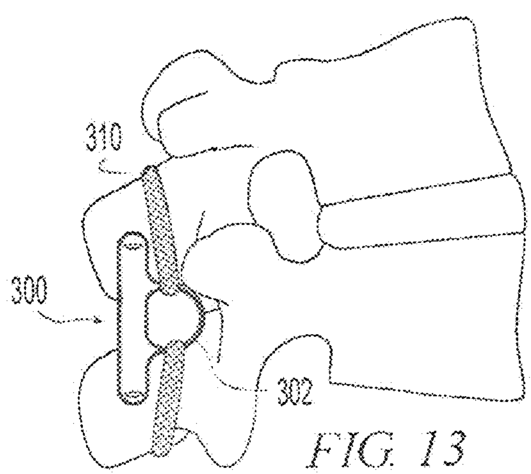

FIG. 13

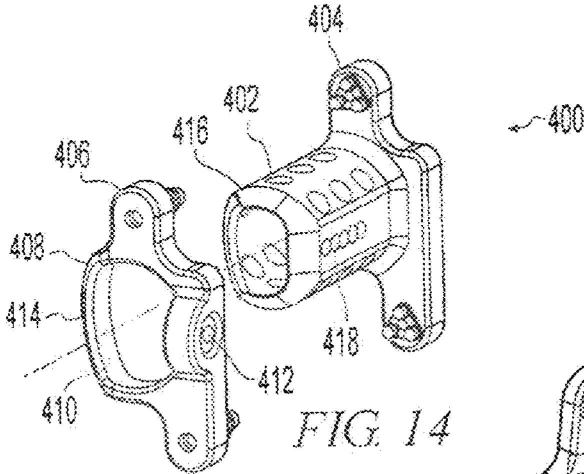

FIG. 14

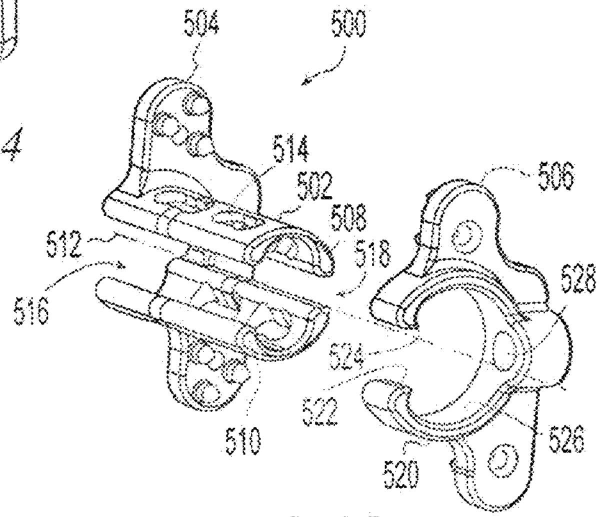

FIG. 15

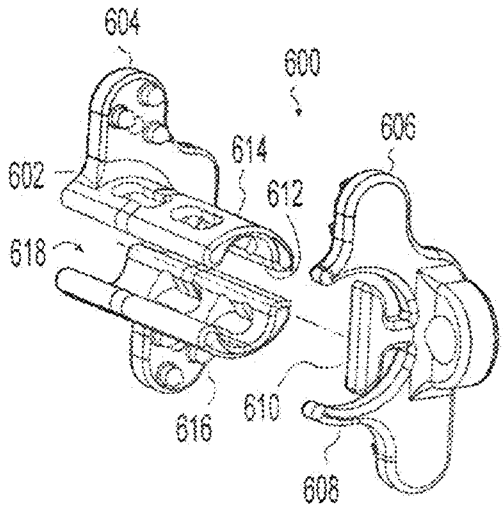

FIG. 16

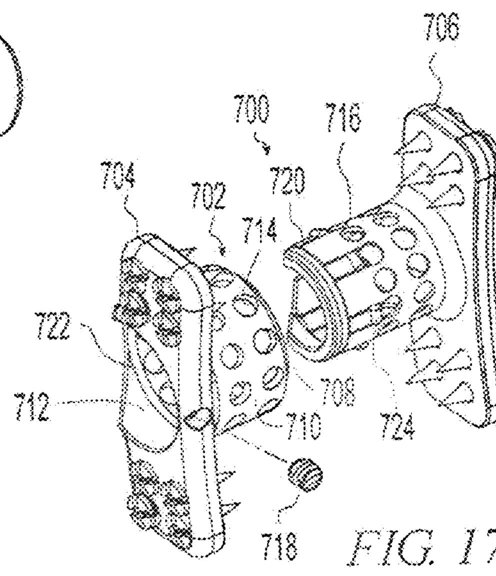

FIG. 17

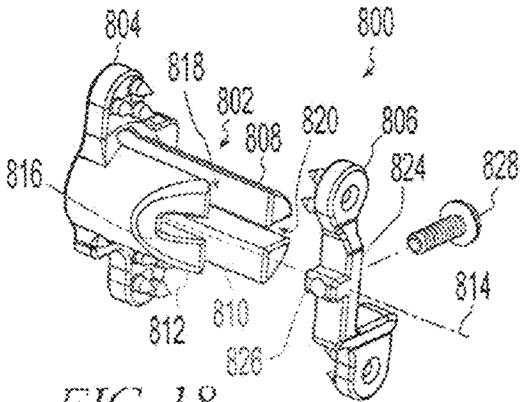

FIG. 18

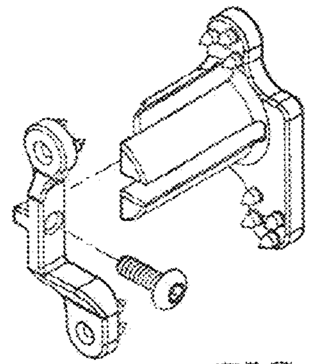

FIG. 19

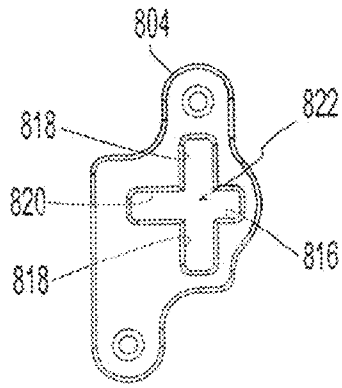

FIG. 20

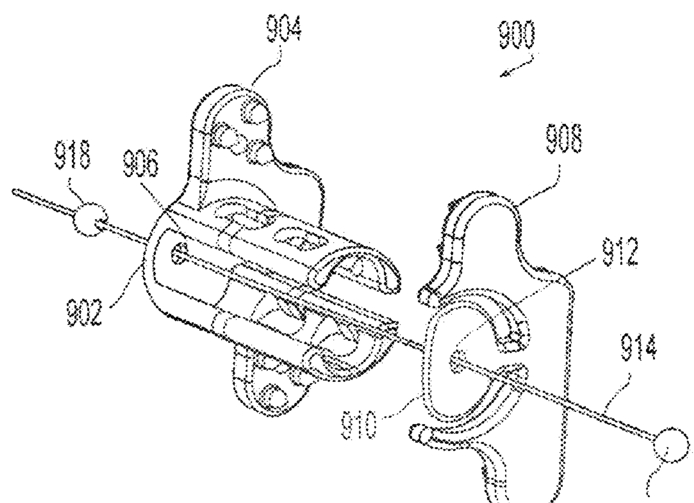

FIG. 21

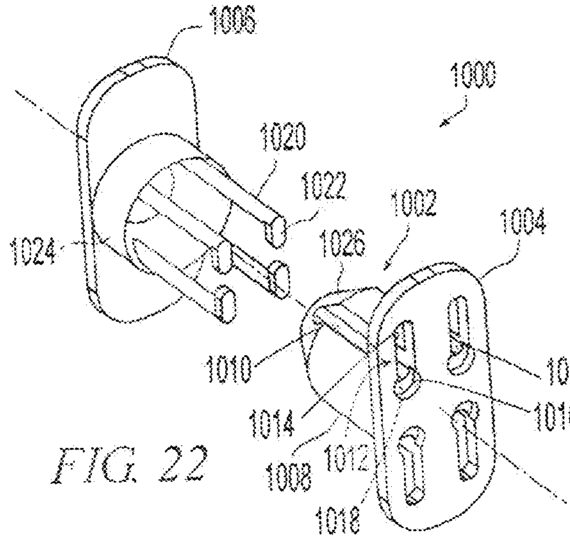

FIG. 22

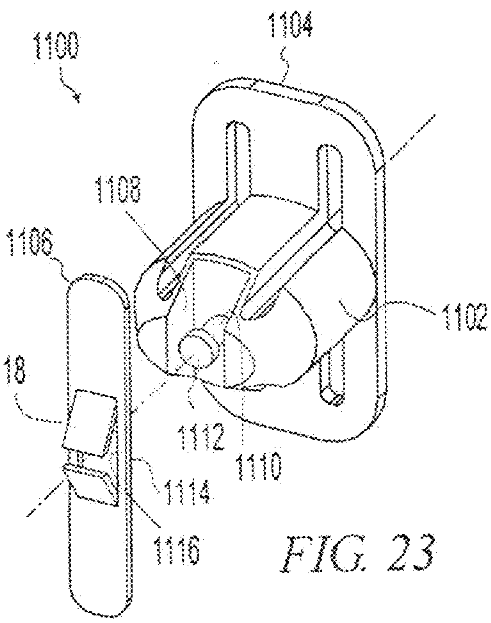

FIG. 23

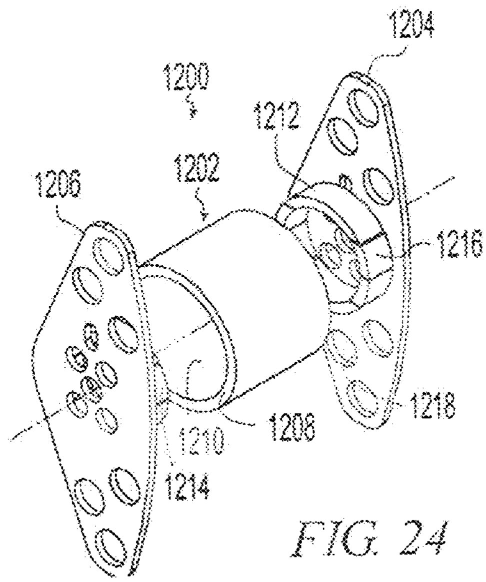

FIG. 24

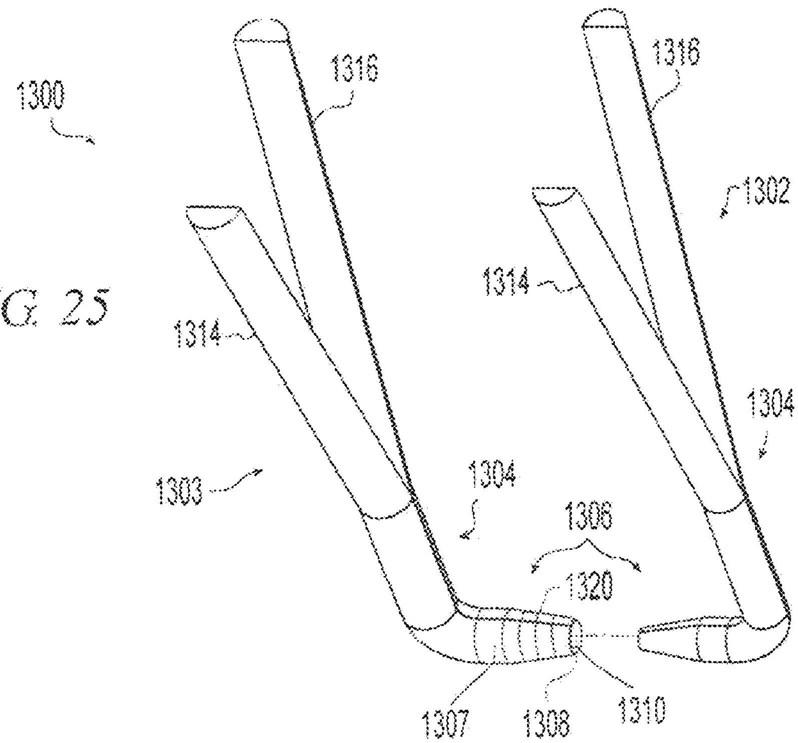
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FIG. 25

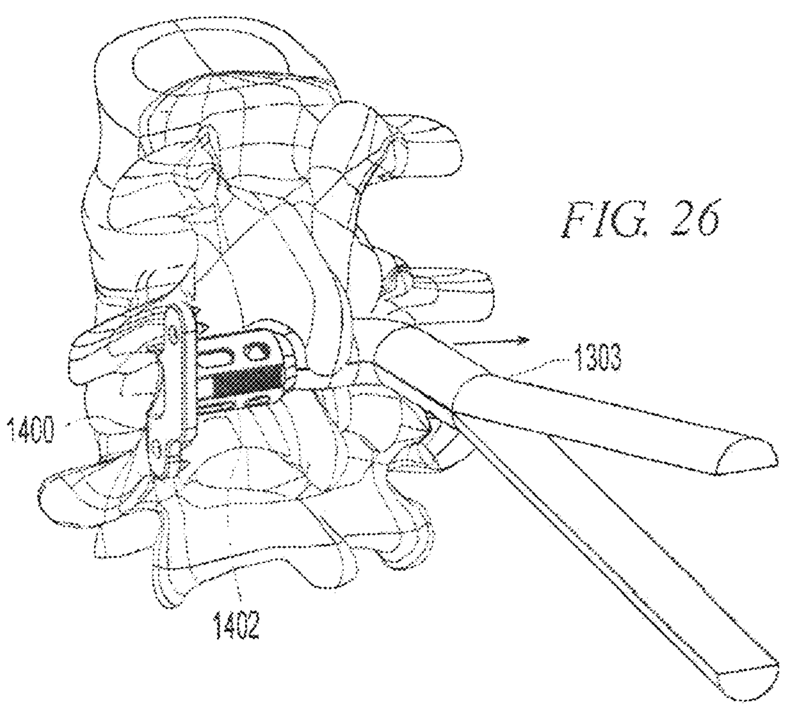
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FIG. 26

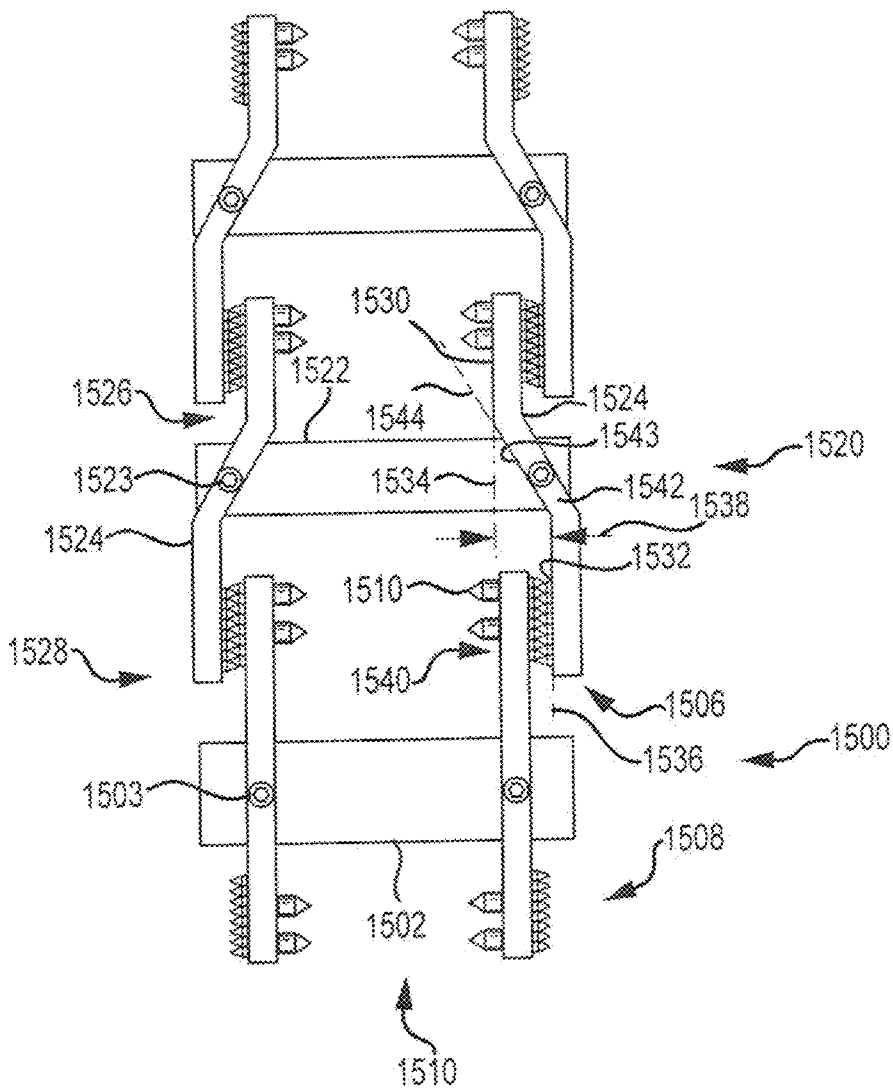
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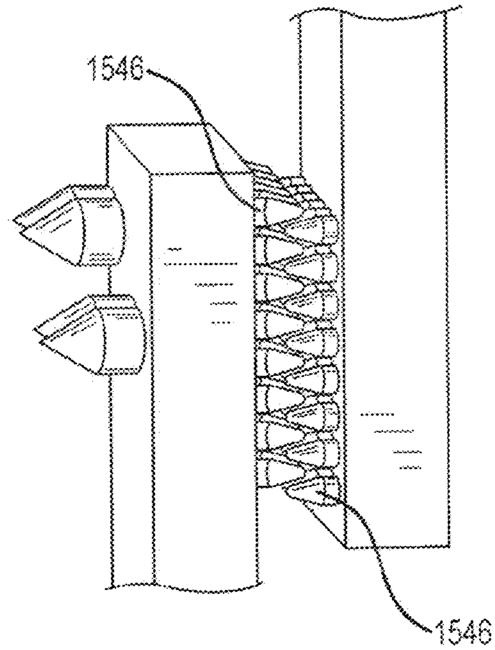
FIG.27



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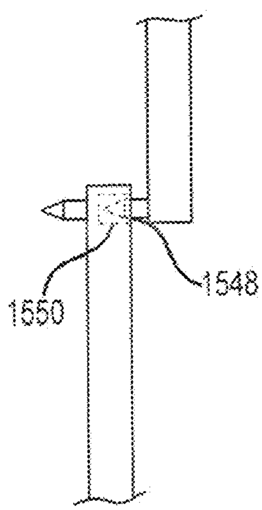

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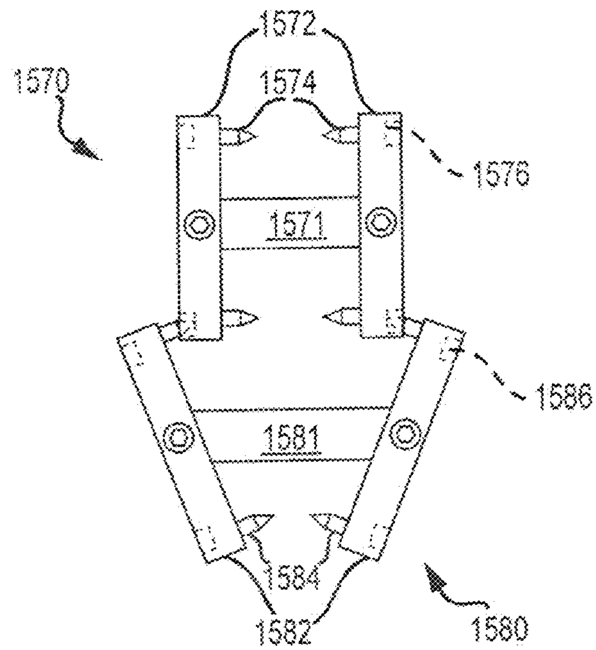

FIG.30

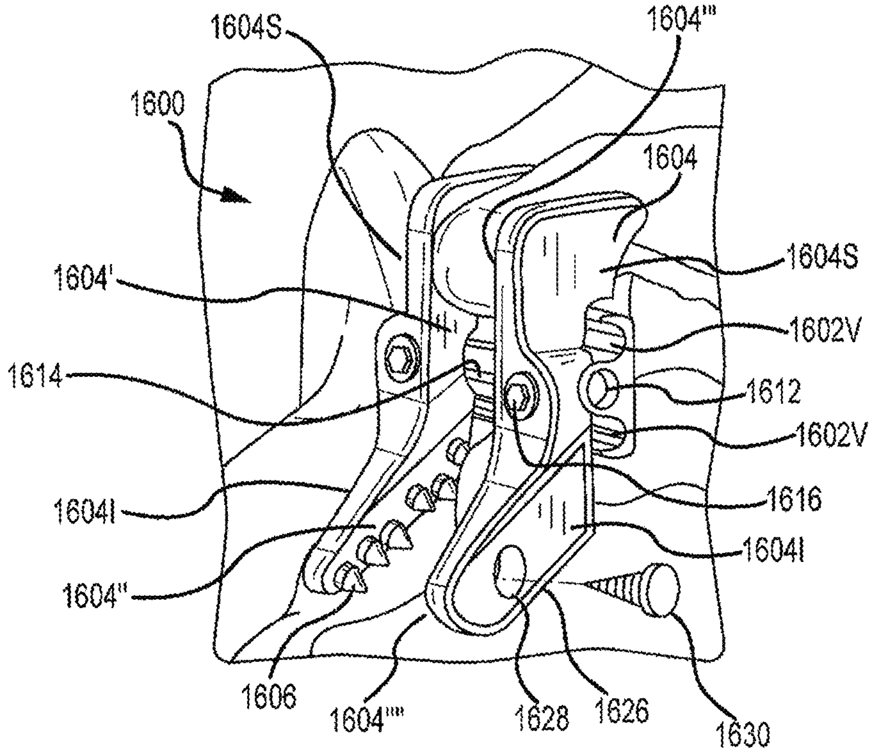
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FIG.31

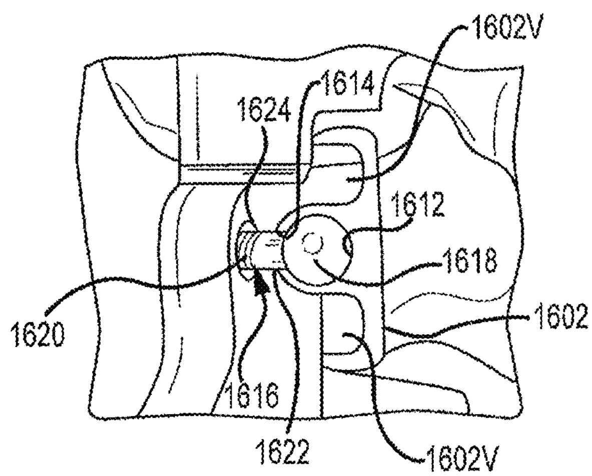
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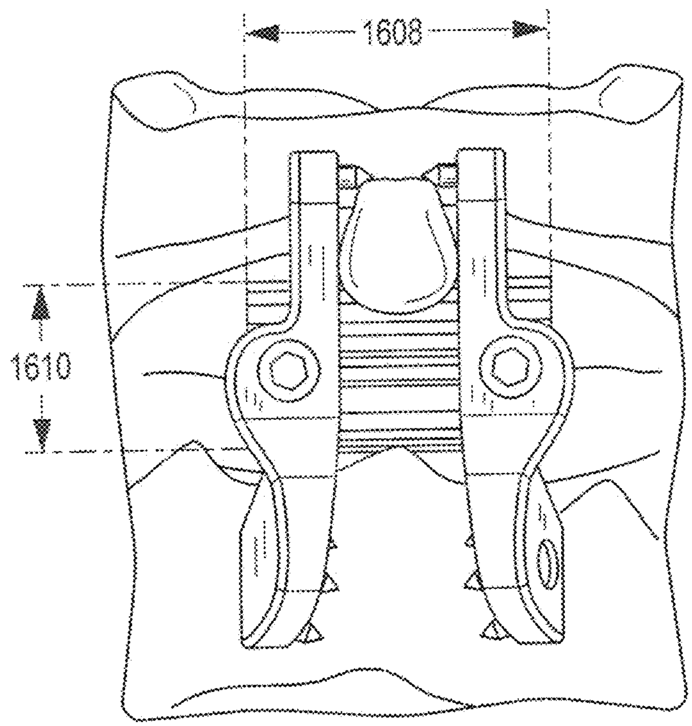
FIG.32



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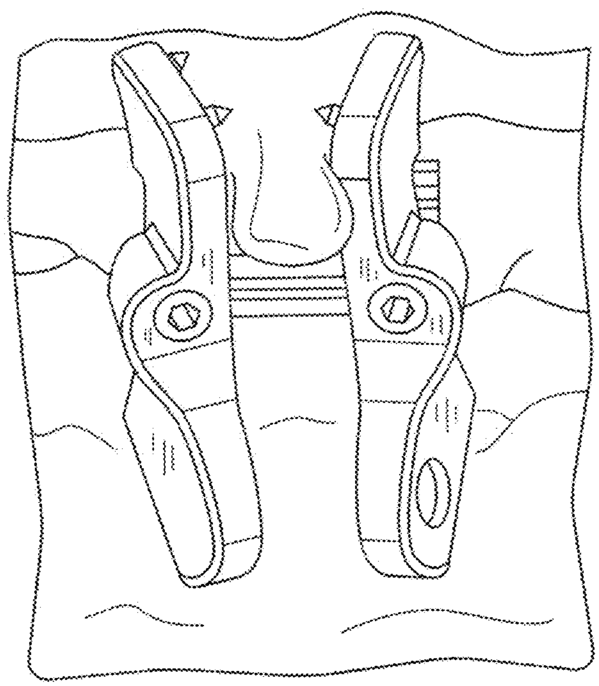

FIG.34

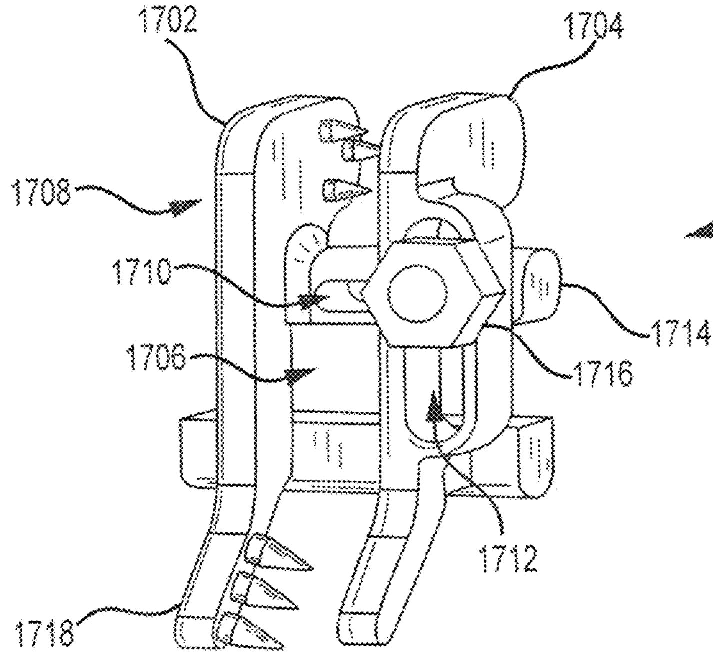

FIG.35

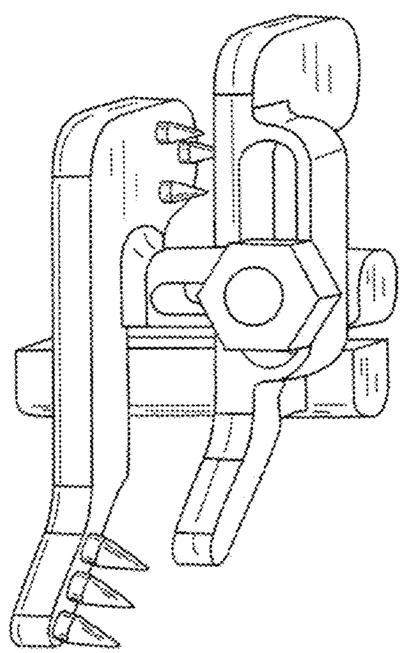

FIG.36

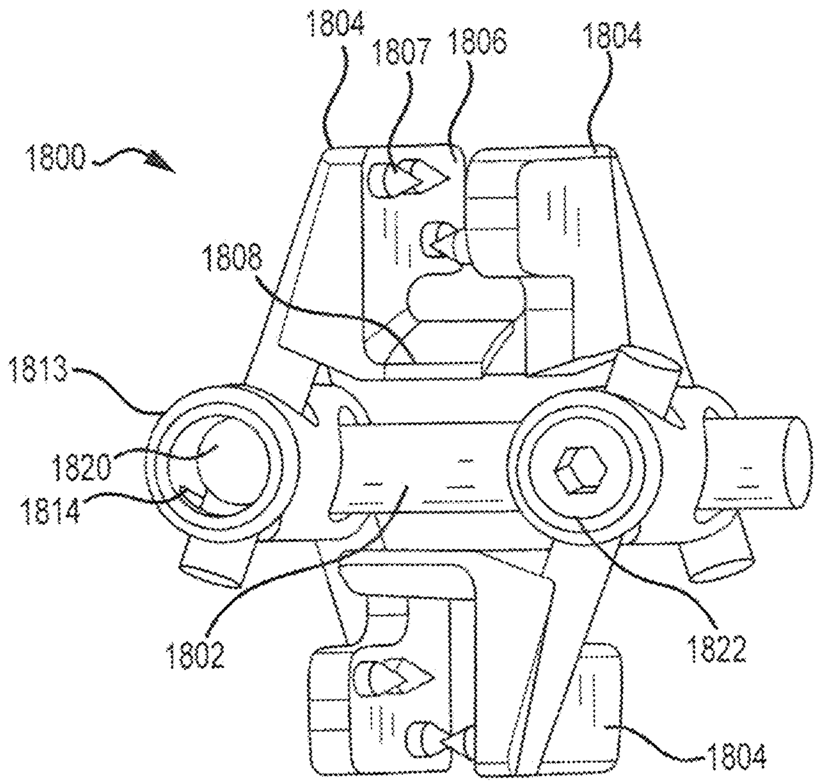
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FIG.37

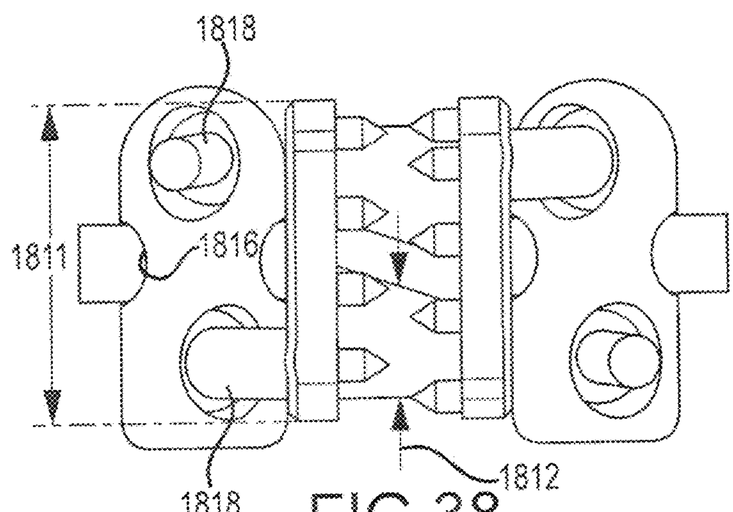
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FIG.38

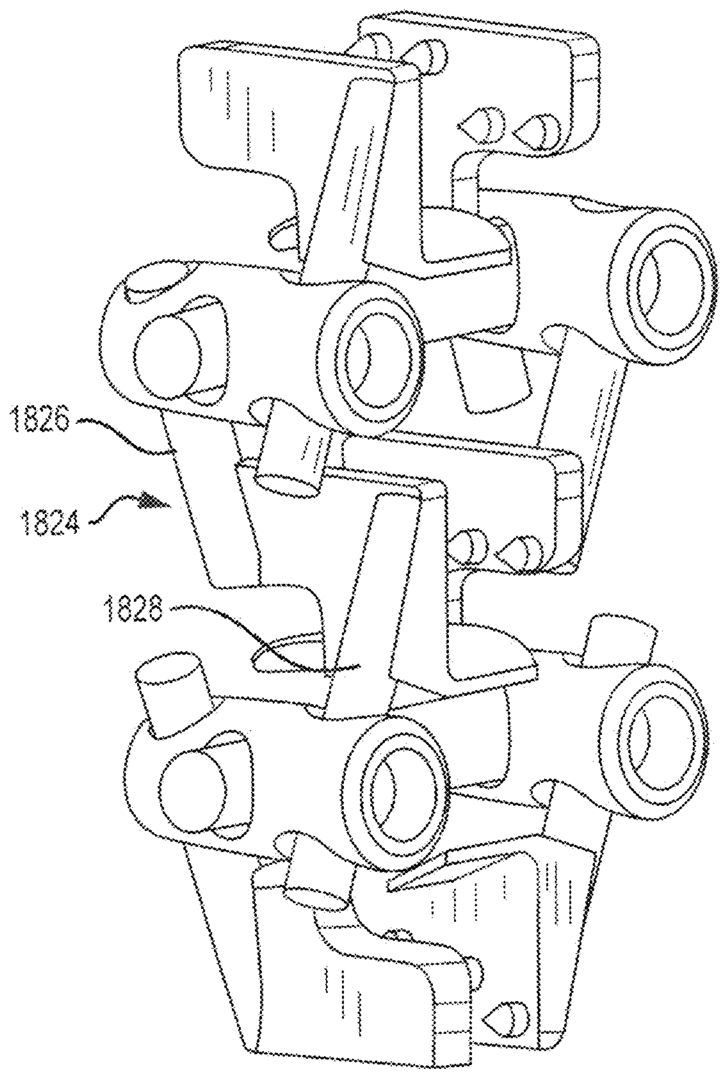


FIG.39

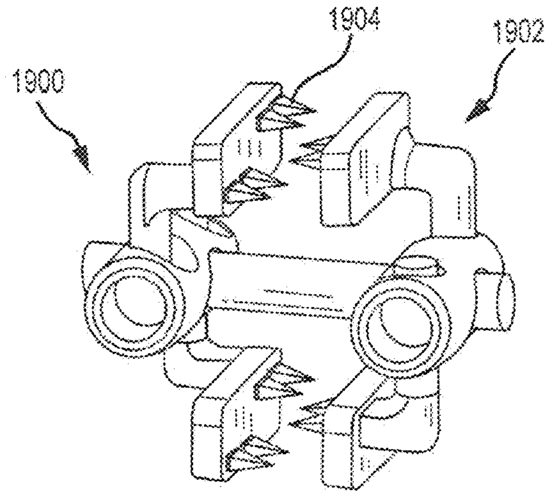


FIG.40

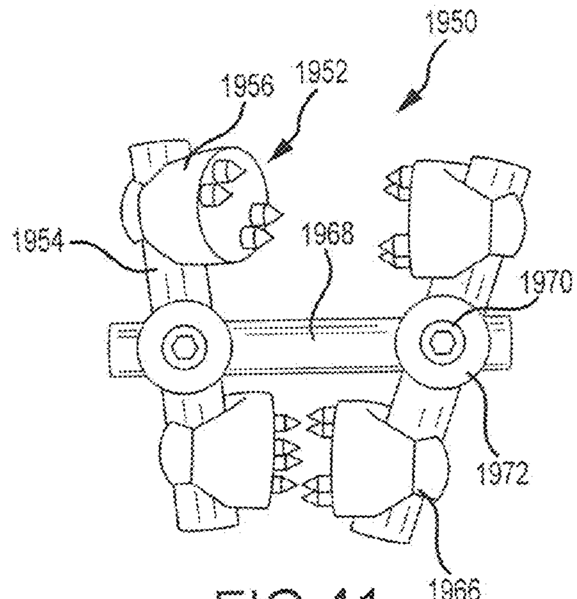
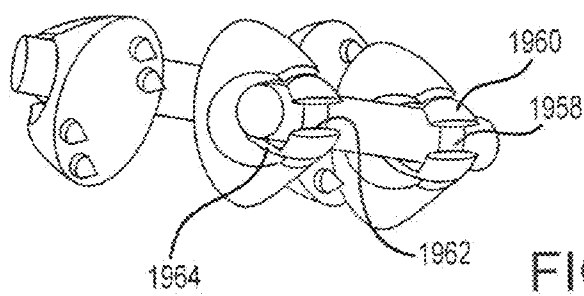


FIG.41



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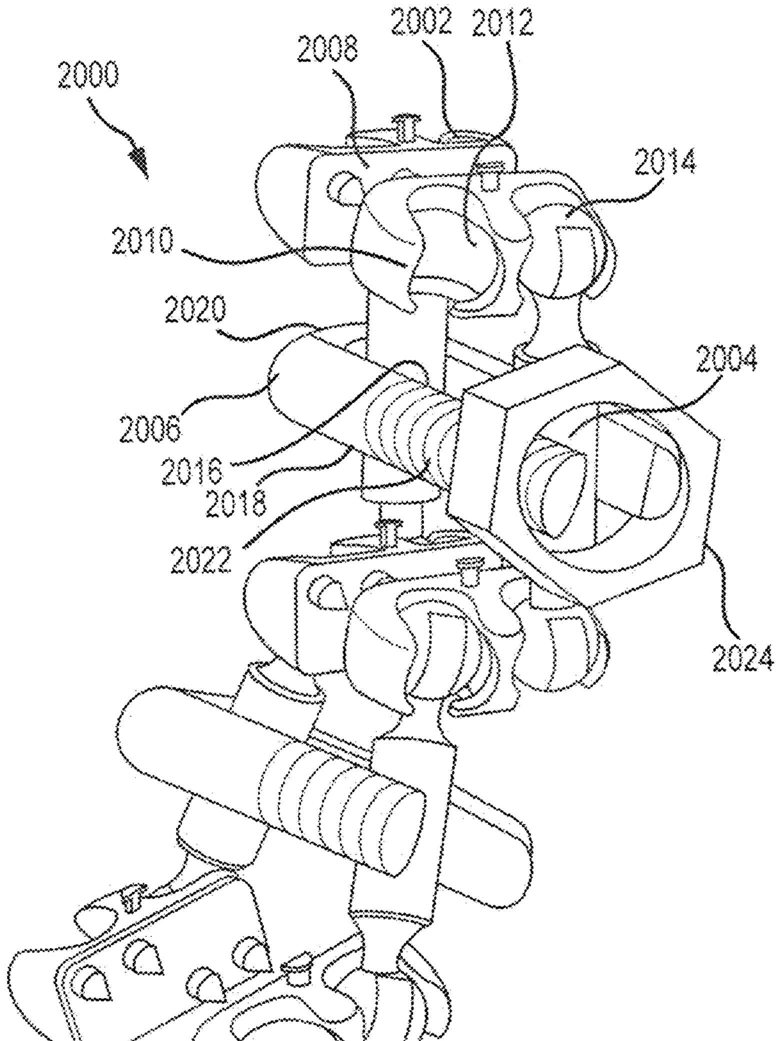
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FIG.43

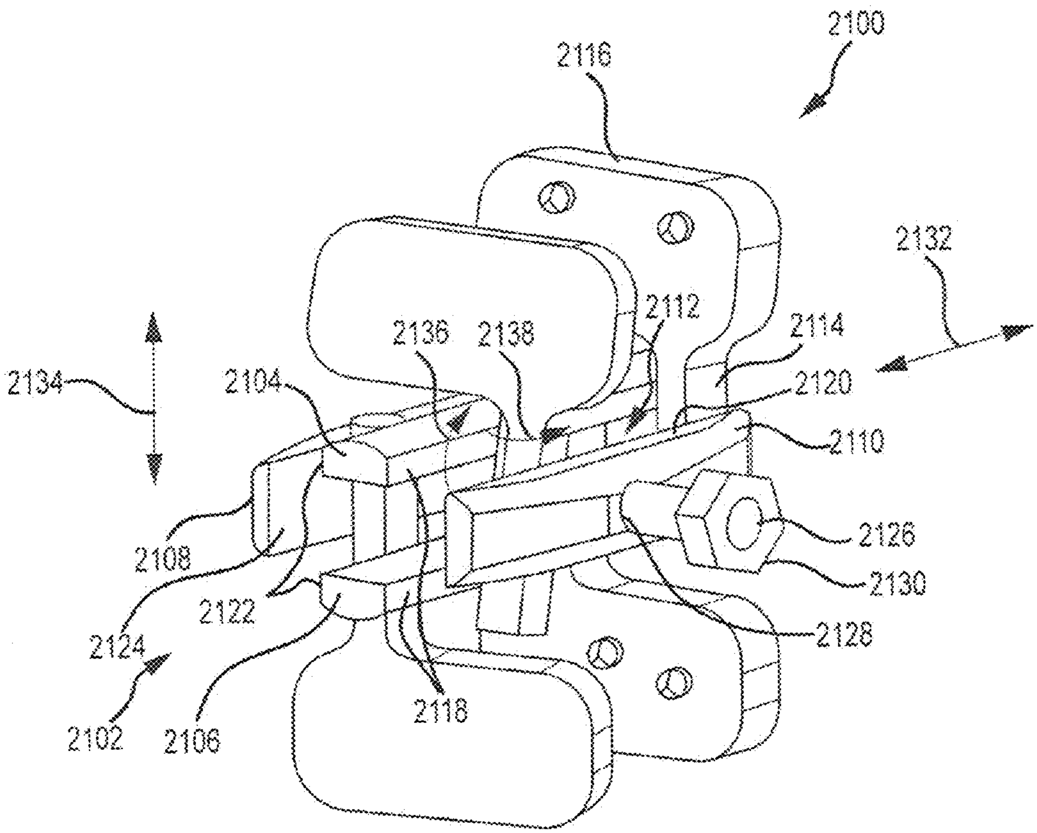
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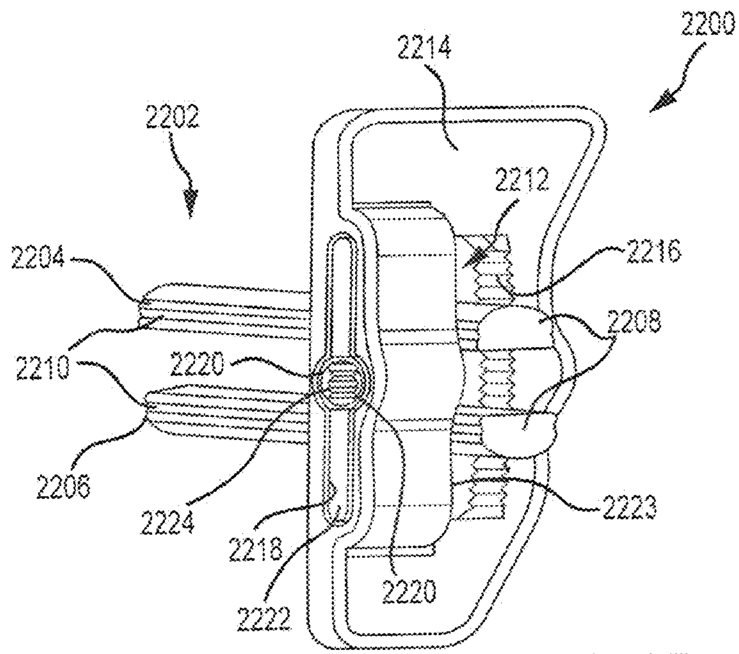
FIG.44



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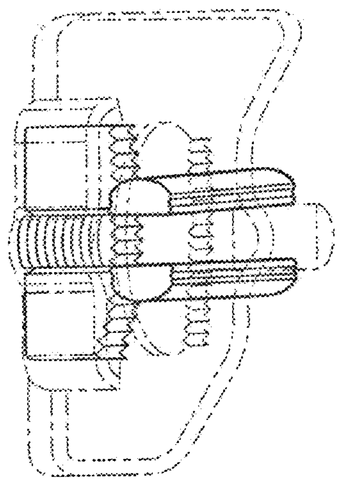


FIG.46

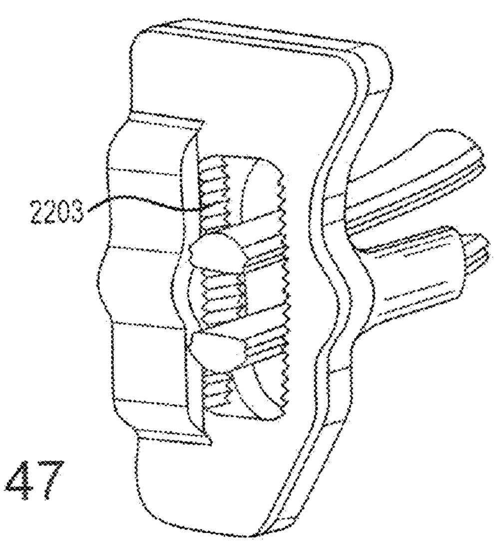
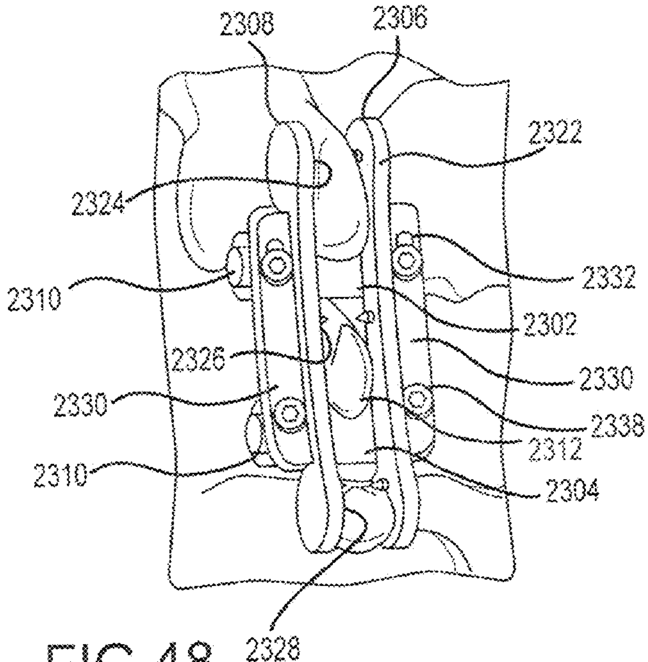


FIG.47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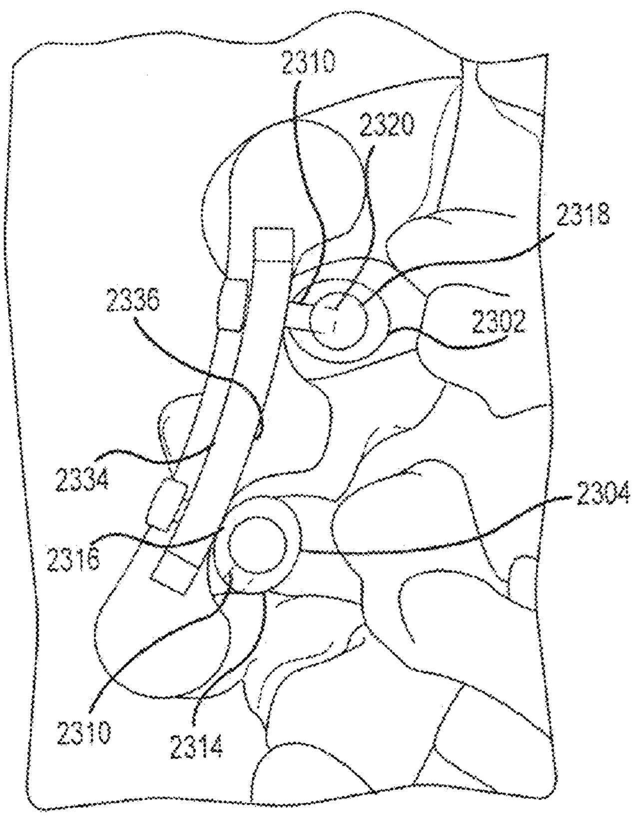
2312
2310
2304
2328

FIG.48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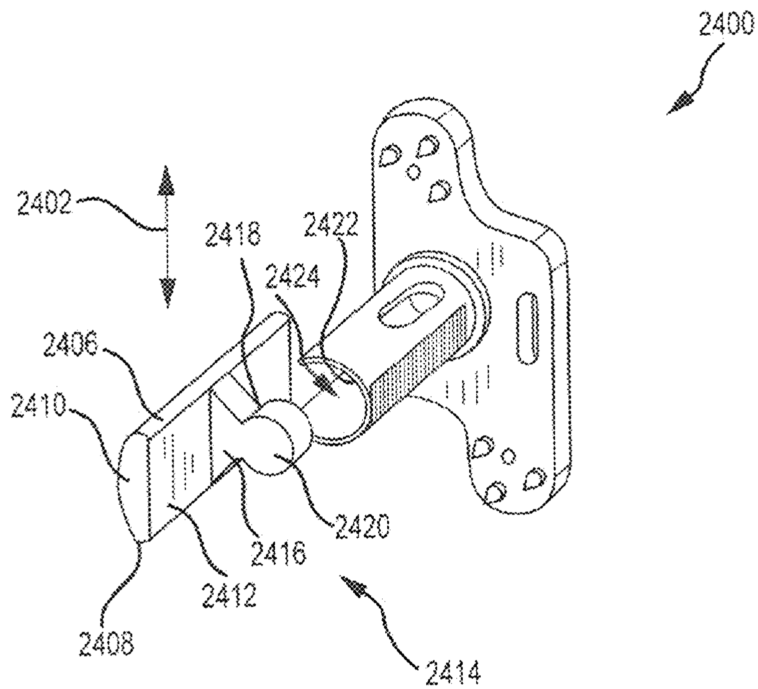
2318
2336
2302
2334
2304
2316
2310
2314

FIG.49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2402
2418
2422
2424
2406
2410
2420
2416
2412
2408
2414

FIG.50

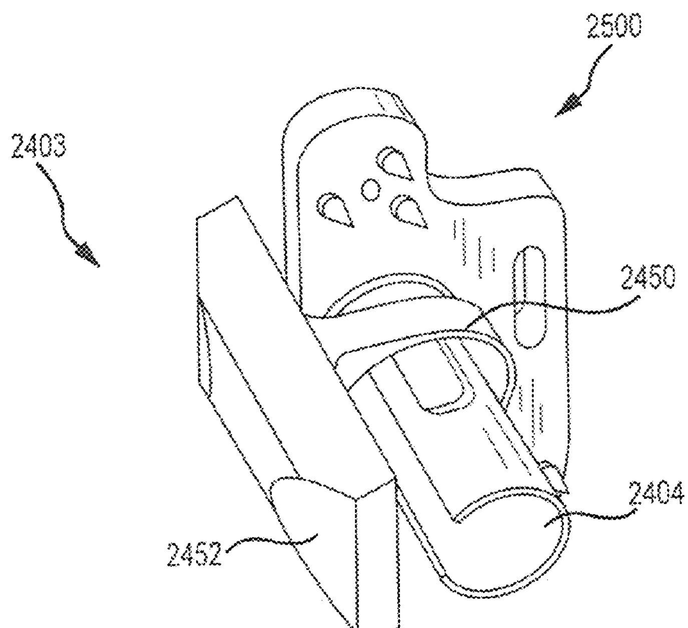
2500
2403
2450
2404
2452

FIG.51

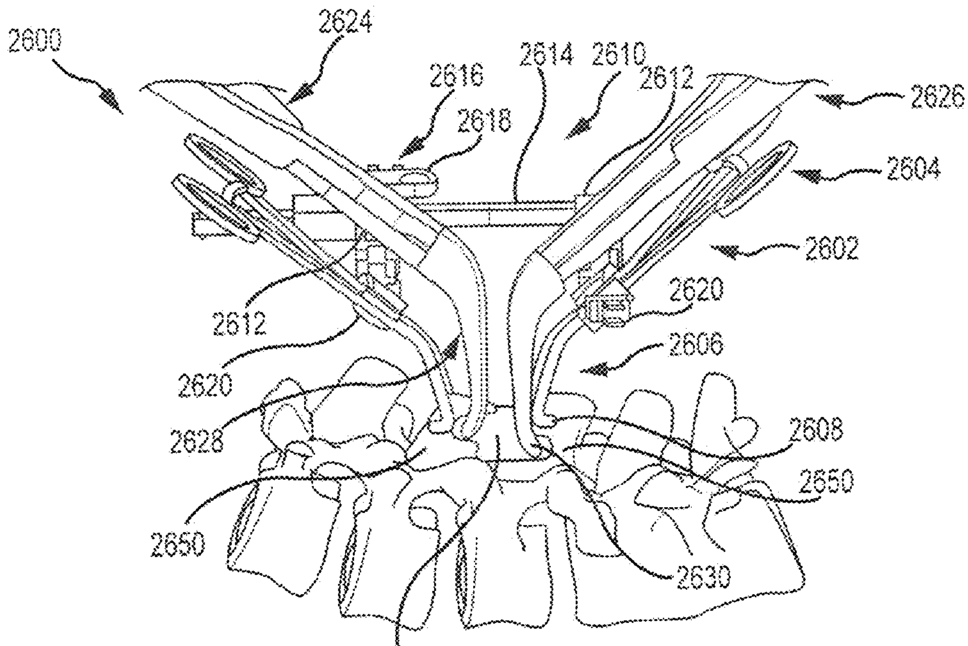
2600
2624
2616
2618
2614
2610
2612
2626
2604
2602
2620
2612
2620
2606
2628
2608
2650
2650
2630
100

FIG.52

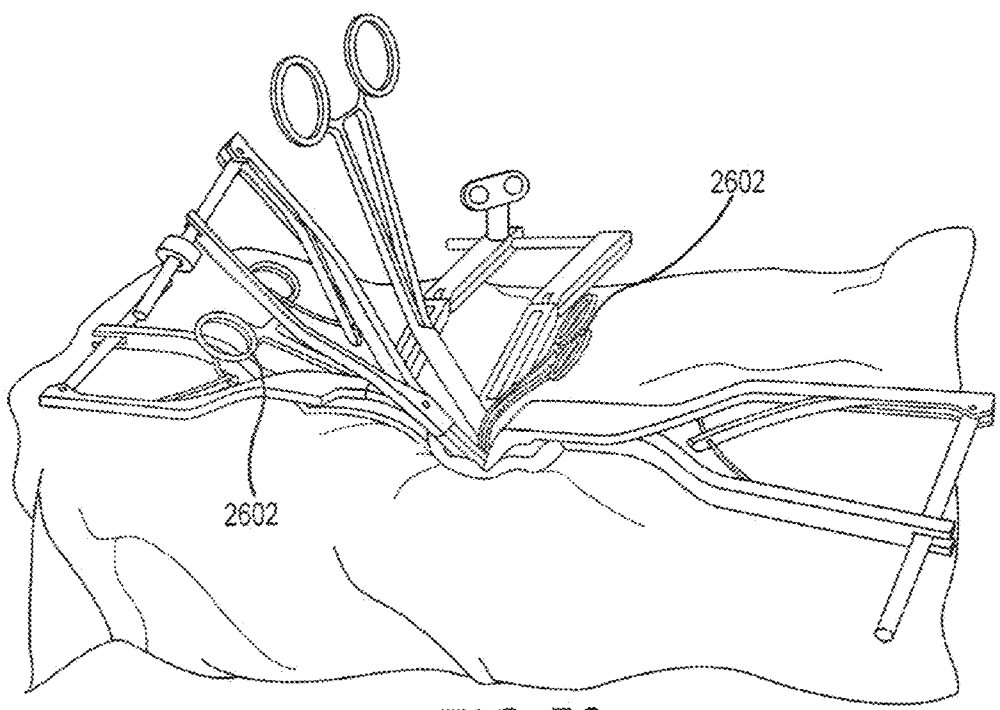
2602
2602

FIG.53

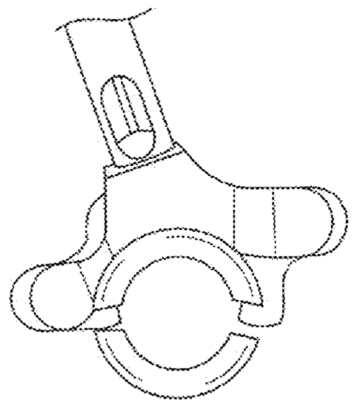

FIG.54

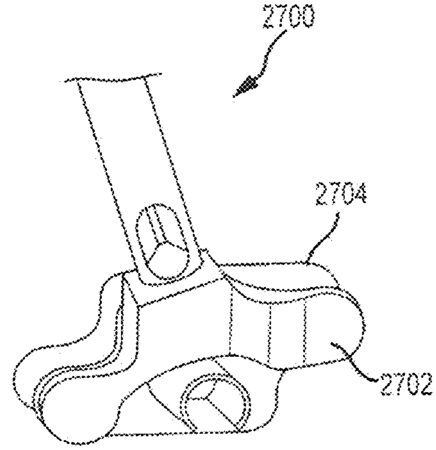

FIG.55

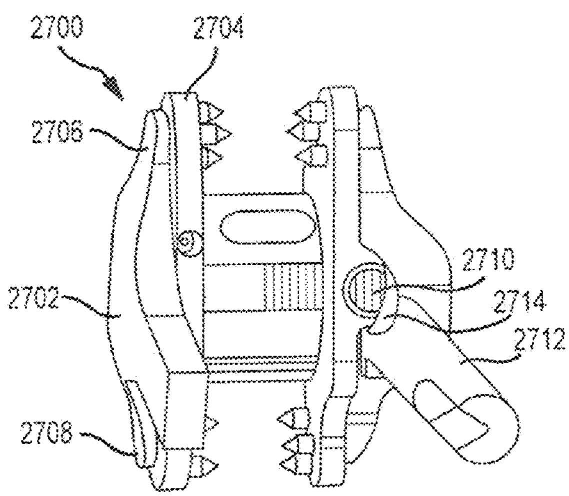

FIG.56

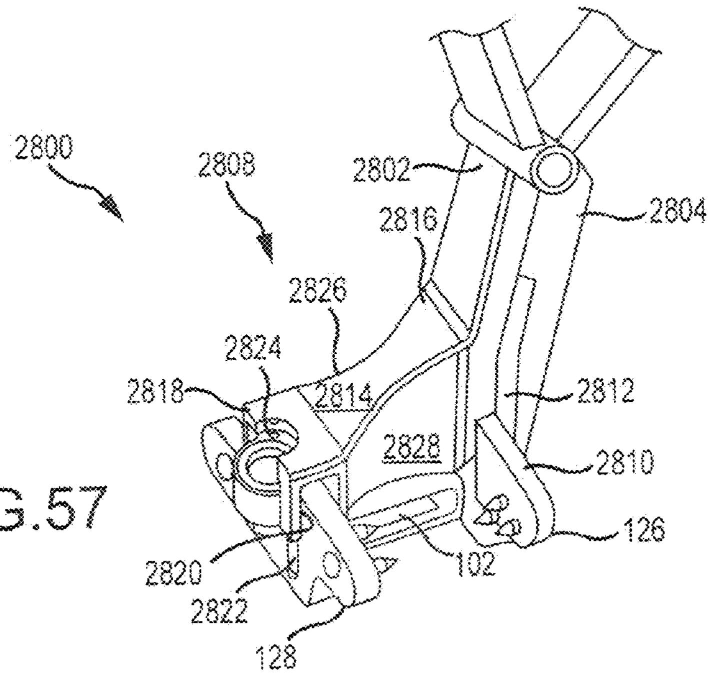
2800
2808
2802
2804
2816
2826
2824
2818
2814
2812
2828
2810
126
102
2820
2822
128

FIG.57

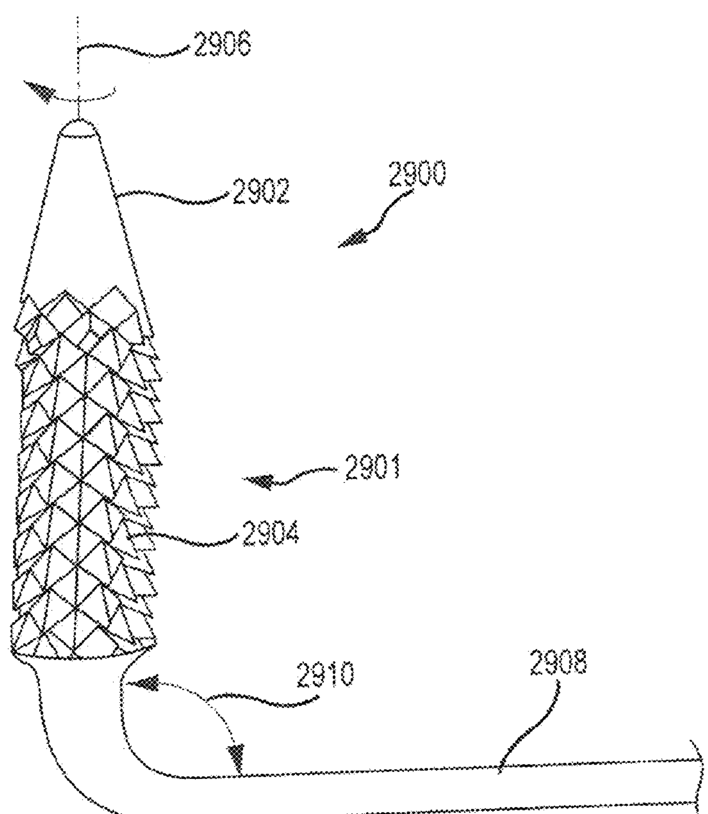
2906
2902
2900
2901
2904
2910
2908

FIG.58

SPINOUS PROCESS IMPLANTS AND ASSOCIATED METHODS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 11/934,604, filed Nov. 2, 2007, which claims the benefit of U.S. Provisional Application No. 60/912,273, filed Apr. 17, 2007 and U.S. Provisional Application No. 60/884,581, filed Jan. 11, 2007, all of which are hereby incorporated by reference in their entirety. This application further claims the benefit of U.S. Provisional Application No. 61/165,354, filed Mar. 31, 2009, which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates to spinous process implants and associated methods.

BACKGROUND

The vertebrae of the human spine are arranged in a column with one vertebra on top of the next. An intervertebral disc lies between adjacent vertebrae to transmit force between the adjacent vertebrae and provide a cushion between them. The discs allow the spine to flex and twist. With age, spinal discs begin to break down, or degenerate resulting in the loss of fluid in the discs and consequently resulting in them becoming less flexible. Likewise, the disks become thinner allowing the vertebrae to move closer together. Degeneration may also result in tears or cracks in the outer layer, or annulus, of the disc. The disc may begin to bulge outwardly. In more severe cases, the inner material of the disc, or nucleus, may actually extrude out of the disc. In addition to degenerative changes in the disc, the spine may undergo changes due to trauma from automobile accidents, falls, heavy lifting, and other activities. Furthermore, in a process known as spinal stenosis, the spinal canal narrows due to excessive bone growth, thickening of tissue in the canal (such as ligament), or both, in all of these conditions, the spaces through which the spinal cord and the spinal nerve roots pass may become narrowed leading to pressure on the nerve tissue which can cause pain, numbness, weakness, or even paralysis in various parts of the body. Finally, the facet joints between adjacent vertebrae may degenerate and cause localized and/or radiating pain. All of the above conditions are collectively referred to herein as spine disease.

Conventionally, surgeons treat spine disease by attempting to restore the normal spacing between adjacent vertebrae. This may be sufficient to relieve pressure from affected nerve tissue. However, it is often necessary to also surgically remove disc material, bone, or other tissues that impinge on the nerve tissue and/or to debride the facet joints. Most often, the restoration of vertebral spacing is accomplished by inserting a rigid spacer made of bone, metal, or plastic into the disc space between the adjacent vertebrae and allowing the vertebrae to grow together, or fuse, into a single piece of bone. The vertebrae are typically stabilized during this fusion process with the use of bone plates and/or pedicle screws fastened to the adjacent vertebrae.

Although techniques for placing intervertebral spacers, plates, and pedicle screw fixation systems have become less invasive in recent years, they still require the placement of hardware deep within the surgical site adjacent to the spine. Recovery from such surgery can require several days of hospitalization and long, slow rehabilitation to normal activity levels.

More recently, investigators have promoted the use of motion preservation implants and techniques in which adjacent vertebrae are permitted to move relative to one another. One such implant that has met with only limited success is the artificial disc implant. These typically include either a flexible material or a two-piece articulating joint inserted in the disc space. Another such implant is the spinous process spacer which is inserted between the posteriorly extending spinous processes of adjacent vertebrae to act as an extension stop and to maintain a minimum spacing between the spinous processes when the spine is in extension. The spinous process spacer allows the adjacent spinous processes to move apart as the spine is flexed.

SUMMARY

The present invention provides a spinous process implant and associated methods.

In one aspect of the invention, an implant for placement between spinous processes of adjacent vertebrae includes a spacer and an extension. The spacer has a sidewall with superior and inferior surfaces operable to abut the spinous processes and maintain the spinous processes in spaced apart relationship. In one example, the sidewall extends generally parallel to a longitudinal axis. In other examples, the sidewall may converge, diverge, or define any other suitable shape relative to a longitudinal axis. The sidewall may be cylindrical, tapered, symmetrical, and/or asymmetrical relative to a longitudinal axis. The extension projects from the spacer transverse to the longitudinal axis to lie generally alongside the spinous processes of adjacent vertebrae and engage the spinous processes to limit the maximum spacing between the spinous processes.

In another aspect of the invention, the extension includes an adjustable fastener.

In another aspect of the invention, the extension includes a removable fastener.

In another aspect of the invention, an implant for placement between spinous processes of adjacent vertebrae includes a spacer having at least one transverse opening communicating from at least one of a superior and inferior outer surface inwardly to facilitate tissue in-growth.

In another aspect of the invention, the spacer includes a hollow interior and a plurality of transverse openings communicating from the superior and inferior outer surfaces to the hollow interior to facilitate tissue growth.

In another aspect of the invention, the spacer includes a porous structure and the transverse openings comprise a plurality of pores.

In another aspect of the invention, an implant for placement between spinous processes of adjacent vertebrae of a spine includes a spacer and separate extensions engageable with the spacer at its ends. The spacer is provided in a variety of lengths and superior to inferior surface spacings:

In another aspect of the invention, an implant for placement between spinous processes of adjacent vertebrae of a spine includes a spacer and a cerclage element. The cerclage element is offset posteriorly of the midline in use so that the spacer defines a fulcrum and the cerclage element is extendible around a portion of a vertebra and operative to impart a moment to the vertebra about the spacer.

In another aspect of the invention, instrumentation includes two instruments each having a working portion tapering from a larger cross-sectional dimension nearer a handle to a smaller cross-sectional dimension near the free end. The free end of one of the instruments defines a hollow tip sized to engage the free end of the first instrument and sized to engage the hollow tip of the implant.

In another aspect of the invention, a method includes inserting a spacer between spinous processes of adjacent vertebrae to provide both an extension stop and a flexion stop.

In another aspect of the invention, a method includes inserting a spacer between spinous processes of adjacent vertebrae and connecting a cerclage element to the adjacent vertebrae to impart a moment to the vertebrae about the spacer.

In another aspect of the invention, a method includes inserting a tapered instrument between adjacent spinous processes; engaging a tip of a spinous process spacer with the tip of the tapered instrument and passing the engaged pair back between the adjacent spinous process to insert the spacer between the spinous processes.

In another aspect of the invention, extensions may be provided that are shaped to allow extensions on adjacent implants to interleave.

In another aspect of the invention, extensions may be provided that permit an extension of one implant to overlie an extension of an adjacent implant.

In another aspect of the invention, an implant for placement between spinous processes may be shaped to accommodate a small or missing spinous process such as, e.g., on the sacrum of a patient.

In another aspect of the invention, an implant for placement between spinous processes may include a spacer that has a variable height.

In another aspect of the invention, an implant for placement between spinous processes may include a mechanism operable to distract adjacent spinous processes away from one another.

In another aspect of the invention, an implant for placement between spinous processes may include bone gripping extensions and a mechanism operable to simultaneously lock a desired horizontal spacing between extensions on opposing sides of a single spinous process and a desired vertical spacing between extensions engaged with adjacent spinous processes.

In another aspect of the invention, an implant for placement between spinous processes may include a spacers and/or extensions engageable with more than two spinous processes to constrain the motion of multiple spinal levels.

In another aspect of the invention, an implant for placement between spinous processes may include first and second spacers. The first and second spacers may be made of different materials.

BRIEF DESCRIPTION OF THE DRAWINGS

Various examples of the present invention will be discussed with reference to the appended drawings. These drawings depict only illustrative examples of the invention and are not to be considered limiting of its scope.

FIG. **1** is a cross sectional view of an implant according to the present invention in situ;

FIG. **2** is a side elevational view of the implant of FIG. **1** in situ;

FIG. **3** is a an exploded perspective view of the implant of FIG. **1**;

FIG. **4** is a front elevational view of the implant of FIG. **1**;

FIG. **5** is a back elevational view of the implant of FIG. **1**;

FIG. **6** is a top plan view of the implant of FIG. **1**;

FIG. **7** is a front elevational view of the implant of FIG. **1** showing the assembly in an alternate position;

FIG. **8** is a side elevational view of the implant of FIG. **1**;

FIG. **9** is a perspective view of a pair of implants like that of FIG. **1** in situ;

FIG. **10** is a cross sectional view of an implant like that of FIG. **1** illustrating an alternate material and cerclage elements;

FIGS. **11-13** are side elevational views of an implant like that of FIG. **1** shown in use with cerclage elements;

FIGS. **14-24** are perspective views of alternative embodiments of the invention;

FIG. **25** is a perspective view of instrumentation for implanting the implant of FIG. **1**;

FIG. **26** is a perspective view of the instrumentation of FIG. **25** in use to implant the implant of FIG. **1**.

FIGS. **27-58** are perspective views of aspects of the invention.

DESCRIPTION OF THE ILLUSTRATIVE EXAMPLES

Embodiments of spinous process implants according to the present invention include a spacer and an extension extending outwardly from the spacer. The spinous process implant May be configured for insertion between adjacent spinous processes of the cervical, thoracic, and/or lumbar spine. The spacer may be provided in a variety of sizes to accommodate anatomical variation amongst patients and varying degrees of space correction. The spacer may include openings to facilitate tissue in-growth to anchor the spacer to the vertebral bodies such as tissue in-growth from the spinous processes. The spacer may be configured for tissue in-growth from superior and inferior spinous processes to cause fusion of the adjacent spinous processes. The openings may be relatively large and/or communicate to a hollow interior of the spacer. A hollow interior may be configured to receive bone growth promoting substances such as by packing the substances into the hollow interior. The openings may be relatively small and/or comprise pores or interconnecting pores over at least a portion of the spacer surface. The openings may be filled with bone growth promoting substances.

The spacer may have any suitable cross-sectional shape. For example, it may be cylindrical, D-shaped, C-shaped, H-shaped, include separated cantilevered beams, and/or any other suitable shape. The shape may include chamfers, fillets, flats, relief cuts, and/or other features to accommodate anatomical features such as for example the laminae and/or facets. The spacer may have a sidewall that is generally parallel, tapered, or irregularly shaped. The spacer may have a fixed height or it may have a variable height allowing for adjustment intraoperatively. A single spacer may be provided for a single level of spine correction or multiple spacers may be provided for a single level or multiple levels of spine correction. Where multiple spacers are provided, they may be made of the same or different materials.

The extension may extend transversely from the spacer relative to a spacer longitudinal axis to maintain the spacer between adjacent spinous processes. A single extension may extend in one or more directions or multiple extensions may be provided that extend in multiple directions. One or more extensions may be adjustable longitudinally relative to one another and/or the spacer to allow the extensions to be positioned relative to the spinous processes. A moveable extension may be provided that is movable axially relative to the spacer and another extension. Alternatively, a plurality of moveable extensions may be provided. For example, the extensions may clamp against the sides of the spinous processes to immobilize the spinous processes relative to one another and promote fusion between the adjacent vertebrae. The extensions may include fasteners engageable with the spinous processes. The fasteners may include sutures, wires, pins, straps, clamps, spikes, screws, teeth, adhesives, and/or other suitable fasteners. The fasteners may be integrated into the extensions or they may be modular. Modular fasteners may be adjustable, replaceable, and/or removable to allow tailoring of the kind and quality of fixation from rigid fixation to no fixation.

Extensions may be provided that permit an extension of one implant to overlie, or overlap, an extension of an adjacent implant. For example, the extensions may overlap similar to shingles overlapping. The extensions may be offset to further facilitate the overlapping of adjacent extensions. The extensions may have smooth surfaces that facilitate relative motion between overlapping portions of extensions. The extensions may have surfaces that engage one another to resist relative motion; for example, opposing surfaces of overlapping extensions may include pads, hooks, pins, teeth, bristles, surface roughness, adhesive, holes, loops, screws, bolts, and/or other features that permit one extension to grip another.

The implant may be shaped to accommodate a small or missing spinous process such as, for example, on the sacrum of a patient. For example, a portion of one or more extensions may flare outwardly to seat on a relatively broader and/or flatter portion of a bone such as the sacrum. Such an extension may include fasteners that are longer, sharper, and/or otherwise adapted to penetrate and grip the bone. The extensions may be angularly variable relative to one another to accommodate the shape of the underlying bone.

The spacer may have a fixed height or a variable height. A variable height spacer may include a first portion and a second portion having a variable height spacing that may be locked at a desired relative spacing. The height spacing may be adjustable and/or lockable simultaneously with or independently from a horizontal bone gripping spacing of the extensions. The height spacing may be adjustable by exerting a spacing force on a first and second portion with a removable instrument and then locking the desired spacing. The height spacing may be adjustable by operation of a mechanism incorporated into the implant itself. The height spacing may be adjustable and the desired spacing locked by a single mechanism. Height spacing adjustment of the spacer may be used to distract adjacent spinous processes away from one another.

The implant may include a mechanism for compressing and/or distracting extensions toward or away from one another while they are engaged with the bone of adjacent spinous processes such that the adjacent spinous processes are similarly compressed or distracted away from one another.

The implant may include spacers and/or extensions engageable with more than two spinous processes to treat multiple spinal levels.

The spacer, extensions, and/or fasteners may advantageously be made of different materials. For example, the spacer and extensions may be made of a relatively softer material while the fasteners may be made of a relative harder material. For example, the spacer and/or extension may be made of a polymer and/or other relatively soft material and the fastener may be made of a metal and/or other relatively hard material. The different materials may have different transmission properties such that one may appear well defined on a medical image and the other appear only dimly or not at all. For example, a metal portion of an implant will show plainly on an x-ray whereas a polymer portion will be much fainter. These properties can be used to allow a surgeon to see that certain portions, e.g. fasteners are engaged with bone while allowing a clear view through other portions to visualize the treatment site, e.g., the space between bones.

Cerclage may be used to stabilize the spinous process implant and/or to provide other benefits. For example, wires, straps, bands, cables, cords, and/or other elongated members may encircle the pedicles, laminae, spinous processes, transverse processes, and/or other spinal structures. The cerclage may be relatively inextensible to provide a hard check to spine flexion or the cerclage may be relatively extensible to provide increasing resistance to flexion. The cerclage may be relatively flexible and drapeable such as a woven fabric or it may be relatively rigid such as a metal band. The cerclage may have shape memory properties that cause it to resume a prior set shape after implantation. The cerclage may be independent of the spinous process implant or may engage it. For example, the cerclage may pass through a hollow interior of the spinous process implant and/or engage the extension. The cerclage may be offset from the spacer and provide a tensioning force that uses the spacer as a fulcrum to offload the disc and/or open the disc space.

The implant may be supplemented with bone growth promoting substances to facilitate fusion of adjacent vertebrae between spinous processes, laminae, transverse processes, facets, and/or other spinal structures. The bone growth promoting substances may be spaced from the implant, placed adjacent the implant, sandwiched between the implant and underlying bone placed inside the implant, coated onto the implant, and/or otherwise placed relative to the implant. If it is coated onto the implant it may cover the entire implant or only selected portions of the implant such as the extensions, fasteners, spinous process contacting portions of the spacer, and/or other portions.

In addition, bone growth promoting substances may include structural members that contribute directly to the support of the spacing between adjacent vertebrae. For example, a structural bone graft may be incorporated into, onto, around, and/or otherwise associated with the spacer and/or extensions to both provide structural support and a scaffold for new bone formation. For example, a structural piece of bone may engage with the spacer and extend beyond the spacer such that adjacent spinous processes rest on the structural bone.

As used herein, bone growth promoting substances may include bone paste, bone chips, bone strips, structural bone grafts, platelet derived growth factors, bone marrow aspirate, stem cells, bone growth proteins, bone growth peptides, bone attachment proteins, bone attachment peptides, hydroxylapatite, calcium phosphate, other ceramics, and/or other suitable bone growth promoting substances.

The implant and any associated cerclage or other components may be made of any suitable biocompatible material including among others metals, resorbable ceramics, non-resorbable ceramics, resorbable polymers, and non-resorbable polymers. Some specific examples include stainless steel, titanium and its alloys including nickel-titanium alloys, tantalum, hydroxylapatite, calcium phosphate, bone, zirconia, alumina, carbon, bioglass, polyesters, polylactic acid, polyglycolic acid, polyolefins, polyamides, polyimides, polyacrylates, polyketones, fluropolymers, and/or other suitable biocompatible materials and combinations thereof.

The spinous process implant may be used to treat spine disease in a variety of surgical techniques including superspinous ligament sacrificing posterior approaches, superspinous ligament preserving posterior approaches, lateral approaches, and/or other suitable approaches. The spinous process implant may be used to treat spine disease by fusing adjacent vertebrae or by preserving motion between adjacent vertebrae. It may include only an extension stop such as a spacer, only a flexion stop such as flexible cerclage elements, or both a flexion and extension stop. The spinous process implant may be used to reduce loads on the facet joints, increase spinous process spacing, reduce loads on the disc, increase anterior disc spacing, and/or otherwise treat spine disease. Anterior effects may be accomplished by tensioning spine elements posterior to the spacer to apply a mechanical advantage to the spinal construct. Techniques for the spinal process implant may include leaving the tissues at the surgical site unmodified or modifying tissues such as trimming, rasping, roughening, and/or otherwise modifying tissues at the implant site.

FIGS. **1** and **2** depict posterior and lateral views of a pair of adjacent vertebrae of the lumbar spine **10**. A superior vertebra **12** is separated from an inferior vertebra **14** by a disc **16**. Each vertebra includes a pair of transverse processes **18**, **19**, a posteriorly projecting spinous process **20**, **21**, and a pair of laminae **22**, **23** connecting the transverse processes **18**, **19** to the spinous process **20**, **21**. In addition to the connection through the disc **16**, the vertebrae **12**, **14** articulate at a pair of facet joints **24**.

FIGS. **1-9** illustrate an exemplary spinous process implant **100**. The implant **100** includes a spacer **102** positioned between the spinous processes **20**, **21**. The height **104** of spacer **102** limits how closely the spinous processes **20**, **21** can move together. Thus, the spacer **102** maintains a minimum distance between the spinous processes **20**, **21**. In the case of spine disease involving posterior subsidence of the adjacent vertebra, insertion of the spacer **102** between the spinous processes **20**, **21** will move the vertebrae apart and relieve pressure on nerve tissue and the facet joints **24**.

As shown in FIG. **3**, the spacer **102** includes a first end **106**, a second end **108**, and a longitudinal axis **110** extending from the first end to the second end. In the illustrated example, the spacer **102** has a sidewall **112**, generally parallel to the longitudinal axis **110**, including superior and inferior outer surfaces **114**, **116**. Transverse openings **118** (see also FIG. **6**) communicate from the superior and inferior outer surfaces **114**, **116** inwardly to facilitate tissue in-growth. The exemplary spacer **102** includes a hollow interior **120** bounded by an inner surface **122** such that the openings **118** communicate from the outer surface to the hollow interior **120**. Bone growth promoting substances **124** are shown packed into the hollow interior **120** in FIGS. **1** and **2** to promote fusion of the vertebrae **12**, **14** by bone growth between the spinous processes **20**.

The spinous process implant **100** further includes a first extension **126** projecting outwardly from the spacer **102** transverse to the longitudinal axis **110** to lie generally alongside the superior spinous process. Abutment of the first extension **126** with the spinous process **20** helps to maintain the spacer **102** between the spinous processes **20**. In the exemplary spinous process implant **100**, the first extension **126** is fixed relative to the spacer **102** and the implant includes a second extension **128** mountable to the spacer for axial movement relative to the first extension **126**. The second extension **128** may be moved toward the first extension **126** to approximate the width of the spinous process **20** and better stabilize the implant **100**. It is fixed in place by tightening a set screw **130** against the spacer **102**. The extensions **126**, **128** include fasteners **132**, **134**, **136** projecting from the extensions **126**, **128** to engage the spinous process **20** to fix the spacer **102** to the spinous process **20**. FIG. **1** depicts additional bone growth promoting substance in the form of a strips of bone **125** sandwiched between the extensions **126**, **128** along the sides of the spinous processes **20** to promote bone growth along the sides of the spinous processes to further inhance fusion of the vertebrae **12**, **14**. The extensions **126**, **128** preferably extend inferiorly (as shown) as well as superiorly to optionally attach to the inferior spinous processes to immobilize the spinous processes **20** relative to one another while fusion takes place.

The fasteners **132**, **134**, and **136** may take any suitable form. They may be made integral with the extensions **126**, **128** such as by machining or casting them with the extensions or they may be formed separately and permanently attached to the extensions **126**, **128**. Fastener **132** is a sharpened spike that threadably engages the extension **126**. The threaded engagement allows the fastener **132** to be replaced with a different fastener **132**. For example, the fastener **132** may be replaced by one that has a different shape, a different size, a different material, or a different surface coating. The threaded engagement also allows the fastener **132** to be adjusted to extend by varying amounts from the extension **126** to vary how it engages the bone. Thus, the fastener **132** can be adjusted to fit differently shaped bones or to penetrate into a bone by varying amounts. For example, multiple threaded fasteners **132** can be adjusted to extend by different amounts to conform to curved or angled bone. Finally, the threaded engagement allows the user to remove the fastener **132** when fixation is not desired such as when it is desired to use implant **100** in a non-fusion procedure as an extension stop without limiting flexion.

Fasteners **134** and **136** are provided as multi-spike pods allowing a plurality of spikes to be quickly adjusted, changed, or omitted. Fastener **134** includes a non-circular tab **138** engageable with a non-circular opening **140** in the extension **126**. The non-circular engagement prevents the fastener **134** from rotating. The tab **138** may form a press-fit, snap-fit, or other suitable engagement with the opening **140**. The tab **138** may be further secured by a supplemental screw **142**. Fastener **136** includes a threaded shaft **144** threadably engaged with a base member **146** to allow the length of the fastener **136** to be adjusted. The shaft **144** engages the extension **126** in rotating and pivoting manner such that the fastener **136** can be adjusted rotationally and angularly to engage the bone surface. In the illustrative embodiment, the shaft **144** terminates in a spherical ball **148** that engages the opening **140** in a ball-and-socket arrangement for three degrees of freedom. However, any mechanism that allows any number of degrees of freedom may be used. The fastener **136** may be allowed to move in use so that as the extension **126** is pressed toward a bone the fastener **136** adjusts to the angle of the bone surface. The fastener **136** may also be secured such as by screw **142** to adjust the tension in the joint and/or to lock the fastener **136** in a predetermined orientation.

FIG. **4** illustrates the axial relationship of fasteners on the opposing extensions **126**, **128**. In the illustrative implant **100**, the fasteners **132** at the top of the implant **100** are shown aligned along a common axis **150**. The fasteners **134** at the bottom of the implant **100** are shown offset so that they can interleave if necessary as they are pressed into a bone. Any combination of fastener type, number, and alignment may be provided on the implant **100**.

As seen in FIGS. **5** and **6**, the ends **106**, **108** of the spacer **102** include anterior chamfers **152**. These chamfers **152** allow the ends **106**, **108** to clear posteriorly facing structures of the vertebrae **12**, **14** such as the facet joints **24**. Also, as seen in FIGS. **5** and **6**, the spacer **102** is offset anteriorly relative to the extensions **126**, **128** such that the longitudinal axis **110** of the spacer **102** is anterior of the midline **154** of the extensions **126**, **128**. The anterior offset of the spacer **102** allows it to fit deeply between the spinous processes **20**, **21** while the extensions **126**, **128** fit alongside the spinous processes **20**, **21**.

As best seen in FIGS. **3** and **8**, the second extension **128** defines an aperture **155** conforming generally to the cross-sectional shape of the spacer **102**. In the illustrative embodiment of FIGS. **1-9**, the aperture **155** opens anteriorly to form a "C"-shape. Tabs **156** extend inwardly from the superior and inferior portions of the aperture to slidingly engage elongated slots **158** in the superior and inferior surfaces of the spacer **102**. The second extension **128** can be translated longitudinally toward and away from the first extension **126**. Tightening the set screw **130** against the posterior side **160** of the spacer **102** forces the tabs **156** posteriorly against the sides of the slots **158** and locks the second extension **128** in place longitudinally. The posterior side **160** of the spacer **102** may be roughened as shown to better grip the set screw **130**. The set screw **130** may also dig into the surface of the spacer **102** upon tightening to positively grip the spacer **102**. The aperture **155** may conform closely to the spacer **102** to constrain the second extension **128** to generally parallel motion relative to the first extension **126**. Alternatively, the aperture **155** may be larger than the spacer **102** by a predetermined amount to permit a predetermined amount of angular adjustment of the second extension **128** relative to the first extension **126** as shown in FIG. **7** to allow the extension **128** to adjust to the underlying bone surface.

As best seen in FIG. **8**, the second extension **128** includes a first lobe **161** having a first lobe centerline **162** and a second lobe **164** having a second lobe centerline **166**. In the illustrative embodiment, the first lobe centerline **162** and the second lobe centerline **166** are parallel and spaced apart so that the second extension **128** has a generally "Z"-shaped plan form. This shape allows the extension of one implant **100** to interleave, if necessary, with another implant **100** in a multilevel surgery as shown in FIG. **9** to permit close spacing of the implants, and/or longer extension lobes for more extensive bone engagement. In the illustrative embodiment of FIGS. **1-9**, the centerlines **162** and **166** are offset equidistantly from the midline **154** of the second extension **128**. The centerlines **162** and **166** may vary from parallel and they may be offset asymmetrically to form different shapes to accommodate different vertebral anatomy. For example, the shape may be tailored for different portions of the spine **10**. In the illustrative embodiment of FIGS. **1-9**, the first extension **126** has the same shape as the second extension **128**. However, the shape may be varied between the first and second extensions **126**, **128**.

FIG. **10** depicts an implant **200** having a spacer **202** and first and second extensions **204**, **206**. The spacer **202** includes pores **208** for tissue to grow into. The pores **208** may be individual openings spaced from one another, interconnecting openings, or combinations of individual and interconnecting openings. The spacer **202** may be a monolithic block having uniform porosity throughout. Alternatively, the spacer **202** may include an outer porous layer **210** and an inner layer **212** of different composition. For example, the inner layer **212** may be solid, porous, hollow, or some other configuration. A porous inner layer may have pores of a different size and/or distribution than the outer layer **210**. Similarly, any porous portion may have uniform porosity or porosity that varies in pore size or density. A variety of pore configurations are suitable. Preferably the pore size is in the range of 1 μm to 2 mm. More preferably, the pore size is in the range of 1 μm to 500 μm. Still more preferably, the pore size is in the range of 75 μm to 300 μm. The pores may be produced by a variety of processes such as sintering of particles; leaching a soluble component from the material; matting, weaving, or otherwise combining fibers: and/or by any other known process. The pore size may be tailored to preferentially promote hard tissue growth, soft tissue growth, or a combination of hard and soft tissue growth. The extensions **204**, **206** may be solid or they may have large and/or small openings to encourage bone growth in and/or around the extensions **204**, **206**. The spacer **202** and/or extensions **204**, **206** may also be coated as previously described.

The extensions **204**, **206** may be fixed and/or adjustable. In the illustrative implant **200** of FIG. **10**, the first extension **204** is fixed to one end of the spacer **202** and the second extension **206** is translatable along the spacer **202** to allow the extensions to be placed adjacent the spinous processes. The extensions **204**, **206** are shown with optional spikes **214** that may engage the spinous processes **20**, **21** to fix the spinous processes **20**, **21** relative to one another.

FIG. **10** also depicts the use of cerclage in conjunction with the implant **200**. For example, one or more flexible bands **216** are placed around the lamina **22**, **23** to provide a flexion stop. The band **216** may help carry the load exerted on the spikes **214** during spine flexion. Alternatively or in addition to the band **216**, one or more bands **218**, **220** may be placed around the transverse processes **18**, **19**.

FIGS. **11-13** depict additional examples of the use of cerclage in conjunction with a spinous process implant **300** according to the present invention. The implant includes a spacer **302** for placement between adjacent spinous processes **20**, **21** and an extension **304**. In the example of FIG. **11**, a band **310** of flexible material is looped around the spinous processes **20**, **21**. By placing the band **310** behind the areas **312**, **314** where the spinous processes contact the spacer **302** an offset **318** is created. Tightening of the band **310** creates a moment **320**, **322** on each vertebra **12**, **14** that offloads some of the pressure on the disc **16** between the adjacent vertebrae **12**, **14**. With increased tightening of the band **310**, the anterior spacing **324** of the vertebrae **12**, **14** may actually be increased. Thus; by using the spinous process implant **300** in combination with the band **310**, the vertebrae **12**, **14** may be levered apart with the implant **300** being used as the fulcrum. In addition to the advantages already mentioned, this combination produces an anterior disc space effect with a posterior spinous process procedure that is less invasive than typical disc spacing procedures.

In the examples of FIGS. **12** and **13**, the implant **300** includes a mechanism for attaching the cerclage band **310** to the implant **300**. In the example of FIG. **12**, the mechanism includes openings **330**, **332** in the superior and inferior ends of the extension **304**. By attaching the band **310** to the extension **304**, the band **310** and extension **304** help stabilize one another against anterior-posterior displacement. This attachment also helps position the band **310** at a predetermined offset **318** from the spacer **302**. In the example of FIG. **13**, the band **310** is looped through a hollow interior of the spacer **302** itself. In this example, the band is not offset and produces minimal or no moment on the vertebrae.

FIGS. **14-24** illustrate alternative mechanisms for attaching a movable extension to the implant of FIG. **1**. Referring to FIG. **14**, an implant **400** includes a spacer **402**, a first extension **404** and a second, movable extension **406**. The movable extension **406** includes a body in the form of a ring **408** with an inner surface **410** generally conforming to the outer surface of the spacer **402** so that the ring is slidingly receivable on the spacer **402**. A set screw **412** is tightened against the spacer **402** to fix the movable extension **406** at a desired position on the spacer **402**. Tightening of the set screw **412** biases the movable extension **406** posteriorly relative to the spacer **402**. The anterior portion **414** of the ring presses against the anterior portion **416** of the spacer **402** to counter this posterior bias and allow the set screw **412** to lock the extension **406**. The spacer **402** may include a plurality of indentations **418** to create a positive engagement with the set screw **412** at predetermined axial locations. The ring **408** may be sized to permit a predetermined amount of tilting of the extension **406** relative to the spacer **402**.

Referring to FIG. **15**, an implant **500** includes a spacer **502**, a first extension **504**, and a second, movable extension **506**. The spacer **502** includes a plurality of cantilevered beams **508**, **510** projecting parallel to a longitudinal axis **512** away from the first extension **504**. In the example of FIG. **15**, the spacer **502** includes a pair of opposed "C"-shaped beams **508**, **510** with their concave surfaces directed inwardly. The spacer **502** includes openings **514** through the beams **508**, **510** and defines elongated openings **516**, **518** anteriorly and posteriorly between the beams. The movable extension **506** includes a body in the form of an interrupted ring **520**. The ring **520** is open anteriorly and the margins of the opening define posteriorly directed hooks **522**, **524**. The inner surface **526** of the ring conforms generally to the outer surface of the beams **508**, **510** so that the ring is slidingly receivable on the spacer **502**. The open anterior configuration of the ring **520** provides clearance to ease sliding of the ring in-vivo. A set screw **528** is tightened against the spacer **502** to fix the movable extension **506** at a desired longitudinal position on the spacer. The hooks **522**, **524** curve around a portion of the anterior edge of the beams **508**, **510** to resist posterior translation of the ring relative to the spacer **502** when the set screw **528** is tightened.

Referring to FIG. **16**, an implant **600** is depicted that is similar to implant **500** of FIG. **15** having a spacer **602**, first extension **604**, and movable extension **606**. However, the ring **608** is truncated anteriorly to provide even more anterior clearance than the ring **520** of FIG. **15**. The ring **608** includes a key **610** projecting anteriorly from the posterior side of the ring **608** and expanding superiorly and inferiorly to engage the inner surface **612** of the beams **614**, **616** to resist posterior translation of the ring relative to the spacer **602**. The key **610** also partially blocks the hollow interior **618** of the spacer **602** to help retain material optionally packed into the interior **618**.

Referring to FIG. **17**, an implant **700** includes a spacer **702**, a first extension **704**, and a second movable extension **706**. The spacer **702** includes a sidewall **708** defining an outer surface **710** and an inner surface **712**. In the example of FIG. **17**, the spacer **702** is generally in the shape of a hollow flattened cylinder with a "D"-shaped cross section. However, the spacer **702** could be any desirable shape. The spacer **702** includes a plurality of openings **714** communicating from the outer surface **710** to the inner surface **712**. The movable extension **706** includes a projection **716** configured generally like the spacer **702** but being sized to slide within the spacer **702** in telescoping relationship. The projection (or the spacer) may optionally include one or more fixation mechanisms to lock the extensions **704**, **706** at a desired longitudinal spacing. Fixation mechanisms may include a set screw **718**, a ridge **720** forming a snap fit with a groove **722** or other feature, a detent **724** engageable with openings **714**, and/or other suitable fixation mechanisms. Any one or combinations of these mechanisms may be used and they may be reversed from the orientation shown.

Referring to FIGS. **18-20**, an implant **800** includes a spacer **802**, a first extension **804**, and a second, movable extension **806**. The spacer **802** includes a plurality of cantilevered beams similar to FIGS. **15** and **16** except that in this example there are three beams **808**, **810**, **812**. The beams project parallel to a longitudinal axis **814** away from the first extension **804**. In the example of FIG. **18**, the anterior beam **812** includes a posteriorly opening groove **816**. The posterior beams **808**, **810** and anterior beam **812** define an elongated slot **818** between them opening superiorly and inferiorly. The posterior beams **808**, **810** further define an elongated slot **820** between them opening posteriorly. FIG. **20** illustrates a cruciform opening **822** defined by the projection of the groove **816** and slots **818**, **820** projected through the first extension **804**. The movable extension **806** includes a body **824** sized to slidingly engage the slot **818**. An optional lug **826** can project anteriorly into groove **816** to constrain tilting of the movable extension **806** relative to the first extension **804**. The lug **826** can be sized to lit closely within groove **816** to prevent tilting of the movable extension **806** or it can be sized smaller than the groove **816** to permit a predetermined amount of tilt. A set screw **828** is provided to lock the movable extension **806** to the spacer **802**.

Referring to FIG. **21**, an implant **900** is depicted that is configured generally like that of FIG. **16**. However, an end wall **902** adjacent the first extension **904** includes a through bore **906** and the movable extension **908** includes a key **910** with a through bore **912**. The bores **906**, **912** receive a fastener to fix the extensions **904**, **908** at a maximum spacing to prevent them from moving apart. Fasteners may include screws, bolts, nuts, cables, wires, ties, rods, and/or any other suitable fastener. In the example of FIG. **21**, the fastener includes an elongated crimp receiving member **914**, such as a cable, and crimp members **916**, **918**, such as ferrules or compressible beads.

Referring to FIG. **22**, an implant **1000** includes a spacer **1002**, a first extension **1004**, and a second extension **1006**. The spacer **1002** includes an outer surface **1008** defining one or more longitudinal grooves **1010** extending along the outer surface **1008** and through the first extension **1004**. The first extension **1004** includes one or more corresponding slots **1012** having a radially outwardly extending portion **1014** through the first extension **1004** and communicating with the grooves **1010**. The slots **1012** have a radially inwardly extending portion **1016** defining a shoulder **1018** at the end of the grooves **1010**. The second extension **1006** includes one or more corresponding projections **1020** projecting longitudinally toward the first extension **1004** and terminating at a radially inwardly directed tab **1022**. The second extension **1006** further includes a centering bore **1024** having conical opening engageable with a conical free end **1026** of the spacer **1002**. The second extension **1006** is attached to the spacer **1002** by pressing the tabs **1022** against the conical end **1026** of the spacer **1002** to spread the projections outwardly until the tabs **1022** engage the grooves **1010**. The tabs **1022** are slid along the grooves **1010** until they exit through the slots **1012** and the tabs **1022** snap inwardly over the shoulders, **1018** and into the portions **1016**. Abutment of the tabs **1022** against the shoulders **1018** prevents the first and second extensions **1004**, **1006** from moving apart. The engagement of the conical end **1026** of the spacer **1002** with the bore **1024** provides radial stability to the assembly.

Referring to FIG. **23**, an implant **1100** includes a spacer **1102**, a first extension **1104**, and a second extension **1106**. The spacer **1102** includes a transverse groove **1108** with a central boss **1110** having an enlarged head **1112**. The second extension **1106** includes a portion **1114** sized to fit within the groove **1108** and an opening **1116** bordered by one or more angled tabs **1118**. The second extension **1112** is assembled to the spacer by pressing the portion **1114** into the groove **1108** with the central boss **1110** directed into the opening **1116**. As the boss **1110** is pressed through the opening **1116**, the tabs **1118** flex outwardly to allow it to pass. Once the boss **1110** is past the tabs **1118**, the tabs **1118** return to their original position and snap behind the enlarged head **1112**. In this configuration, the boss **1110** retains the second extension **1106** longitudinally and the groove **1108** prevents the second extension **1106** from rotating about the longitudinal axis of the implant **1100**.

Referring to FIG. **24**, an implant **1200** includes a spacer **1202**, a first extension **1204**, and a second extension **1206**. The spacer **1202** includes a solid cylindrical sidewall **1208** defining a hollow interior **1210**. The extensions **1204**, **1206** are similarly configured and each includes a projection **1212**, **1214** sized to fit inside of the spacer **1202**. The extensions **1204**, **1206** may attach to the spacer by press-fitting, snap-fitting, screwing, and/or otherwise engaging the projections **1212**, **1214** with the spacer **1202**. Alternatively, or additionally, the extensions **1204**, **1206** may attach to the spacer **1202** with any of the previously depicted attachment mechanisms such as with a setscrew as shown in FIG. **3** or an elongated fastener as shown in FIG. **21**. In the example of FIG. **24**, the extensions **1204**, **1206** are slotted longitudinally to form flexible petals **1216** that press into the spacer **1202**. The extensions **1204**, **1206** include openings **1218** to allow tissue growth, permit attachment of cerclage members, and/or receive additional fasteners attached to the spinous processes.

The spacer **1202** of FIG. **24** could have openings as shown in some of the other examples. Likewise, the other examples could have a solid surface as shown in FIG. **24**. Similarly the extensions of any of the examples may be solid, have openings, or be otherwise advantageously configured.

Implants according to the present invention may be implanted using a variety of surgical approaches and techniques. Surgical approaches may include superspinous ligament sacrificing posterior approaches, superspinous ligament preserving posterior approaches, lateral approaches, and/or other suitable approaches. Techniques may include leaving the tissues at the surgical site unmodified or modifying the tissues such as trimming, rasping, roughening, and/or otherwise modifying them. For example, in FIG. **1**, a lateral approach is used and the inferior spinous process is cut on its superior surface **26** to enlarge the interspinous space to receive the implant **100**. After the interpinous space is prepared, the spacer **102** is inserted into the interspinous space. If a first extension **126** is present it may be pressed inwardly to lie near or abut one or more spinous processes. If a second extension **128** is used, it is engaged with the spacer **102** and also optionally pressed inwardly. In FIG. **1**, opposing extensions **126**, **128** having inwardly directed bone fasteners have been used and pressed inwardly so that the fasteners **132** engage the spinous processes **20**, **21**. The engagement of the fasteners **132** with the inferior spinous process **21** is not shown in FIG. **1** because the extensions are offset superiorly and inferiorly as shown in FIGS. **3**, **8**, and **9**.

Referring to FIGS. **25** and **26**, a set of instruments **1300** is provided to facilitate lateral insertion of an implant into the interspinous space. The set of instruments includes a plurality of inserters **1302**, **1303** in which each inserter **1302**, **1303** has a first or handle portion **1304** and a second or working portion **1306**. The working portion **1306** is insertable into the interspinous space. Preferably, the handle portion **1304** extends transverse to the working portion **1306** to facilitate holding and manipulating the inserter **1302**, **1303** while the working portion **1306** is in the interspinous space. The handle portion **1304** and working portion **1306** may define a curve, angle, offset, and/or any other suitable transverse orientation. In the example of FIG. **25**, the inserters **1302**, **1303** are generally "L"-shaped. The working portion **1306** tapers from a relatively larger cross-sectional dimension at a first portion **1307** spaced away from its free end **1308** to a relatively smaller cross-sectional dimension at its free end **1308**. In the illustrative embodiment, the working portion is conical and tapers from a larger diameter to a smaller diameter. The end **1308** defines a hollow tip having an opening **1310**. The set of instruments **1300** is provided with a plurality of similarly configured inserters having differently sized working portions **1306** such that the end **1308** of one inserter **1302** will fit inside the opening **1310** at the tip of another inserter **1303**. Optionally, the working portion **1306** may be separated into opposing halves attached to opposing handles **1314**, **1316**. As the opposing handles **1314**, **1316** are moved relative to one another, the opposing halves of the working portion **1306** move relative to one another. In the illustrative embodiment, squeezing the handles **1314**, **1316** toward one another causes the working portion **1306** to expand as the opposing halves of the working portion **1306** open outwardly away from one another.

In use, a first inserter **1302** is inserted into the interspinous space. The first inserter **1302** is relatively small to ease insertion. As the end **1308** is inserted further, the tapered working portion **1306** expands the interspinous space. Optionally, the interspinous space can be further expanded by expanding the working portion while it is inside the interspinous space such as by squeezing the handles **1314**, **1316**. A second, larger inserter **1302** is engaged with the first inserter **1303** by placing its hollow tip over the tip of the first inserter **1303** and then passing the overlapping instruments back through the interspinous space to remove the first inserter **1303** and insert the second inserter **1302**. As the end of the second inserter **1303** is inserted further, the tapered working portion expands the interspinous space. Optionally, the interspinous space can be further expanded by expanding the working portion while it is inside the interspinous space. Progressively larger inserters can be inserted in this fashion until the interspinous space has been expanded to the desired size. Once the desired size has been reached the appropriate implant size may be determined by noting the size of the last inserter. The inserter may optionally include indicia **1320** on the tapered working end corresponding to different spacer sizes to further facilitate sizing the implant. The implant is inserted by engaging the spacer **1402** with the working end of the inserter as shown in FIG. **26**. The implant may be engaged inside of the hollow tip of the inserter or the tip of the inserter may engage a hollow tip on the implant as shown. The spacer **1402** is pressed into the interspinous space as the inserter is withdrawn.

Referring to FIGS. **27-28**, a first implant **1500** includes a spacer **1502** and extensions **1504**. The extensions are generally planar in the anterior-posterior plane as shown in FIG. **27**, and include a superior portion **1506**, an inferior portion **1508**, and spikes **1510** projecting medially from each of the superior and inferior portions to engage spinous processes superior and inferior to the spacer **1502**. The extensions **1504** are mounted to the spacer **1502** to permit the spacing between the extensions to be adjusted such as by surrounding and sliding along a portion of the spacer **1502** and to permit the spacing between the extensions to be locked such as with set screw **1503**. A second implant **1520** includes a spacer **1522**, extensions **1524**, and set screw **1523**. The extensions **1524** include a superior portion **1526** and an inferior portion **1528**. The inferior portion **1528** is offset laterally (outwardly) relative to the superior portion **1526** to facilitate the inferior portion **1528** overlying the superior portion **1506** of the first implant **1500** in a shingle-like arrangement. In the illustrative example, the superior portion **1526** and inferior portion **1528** define medial surfaces **1530**, **1532** lying generally in planes **1534**, **1536** that are generally parallel to one another and offset by a distance **1538**. The distance **1538** is preferably equal to at least the thickness **1540** of the superior portion **1506** of the first implant to allow the inferior portion **1528** of the extension **1524** to lie flat against the superior portion **1506** of the extension **1504**. The offset distance **1538** may be other values that result in an angular engagement of the inferior portion **1528** of the extension **1524** with the superior portion **1506** of the extension **1504**. The offset may be defined by a discreet offset portion **1542** shown as a generally straight portion defining a medial surface **1543** lying generally in a plane **1544** transverse to planes **1534** and **1536**. Alternatively, any one or combination of portions **1526**, **1528**, and **1544**, including surfaces **1530**, **1532**, and **1543** may be flat, curved, or otherwise shaped. Likewise, the offset may be reversed so that the extensions of first implant **1500** overlie the extensions of second implant **1520**.

Preferably, the inferior portion **1528** of extension **1524** includes a medially facing gripping feature and the superior portion **1506** of extension **1504** includes a cooperating laterally facing gripping surface. In the illustrative example of FIG. **27**, shown more clearly in FIG. **28**, the gripping surfaces include a plurality of conical bristles **1546** able to nest together to resist relative sliding between the extensions **1504**, **1524**. FIG. **29** illustrates an alternative arrangement in which a spike **1548** from one extension engages a hole **1550** in another extension.

In use, the first implant is placed with its spacer between adjacent spinous processes at a first spinal level and the spikes of its extensions engaging the sides of the adjacent spinous processes. A second implant is then placed with its spacer between adjacent spinous processes at a second spinal level and the spikes at one end of its extensions engaging the sides of a spinous process and the other end overlying and engaging the extensions of the first implant.

Referring to FIG. **30**, two implants **1570**, **1580** are shown in overlapping relationship. Implant **1570** includes a spacer **1571** and generally planar extensions **1572** having medially facing spikes **1574** and laterally facing sockets **1576**. The extensions **1572** are able to engage the spacer **1571** at variable angles. Implant **1580** likewise includes a spacer **1581** and generally planar extensions **1582** having medially facing spikes **1584** and laterally facing sockets **1586**. The extensions **1582** are able to engage the spacer **1581** at variable angles. The spikes of the extensions of one implant are receivable in the sockets of the extensions of another implant at varying angles from coaxial, or parallel, to angles as high as 45 degrees or higher. In use, one implant is placed with its spacer between adjacent spinous processes at a first spinal level and the spikes of its extensions engaging the sides of the adjacent spinous processes. A second implant is then placed with its spacer between adjacent spinous processes at a second spinal level and the spikes at one end of its extensions engaging the sides of a spinous process and the spikes at another end of its extensions engaging sockets in the extensions of the first placed implant.

In the illustrative example of FIG. **30**, no offset is required in the extensions to permit an overlying relationship due to the variable angle between the extensions and the spacers. The implants of FIG. **27** may likewise permit variable angles between extensions and spacers. However, because of the offset of the extensions, the extensions will assume a more parallel orientation. The implants of FIGS. **27-30** may incorporate features of any of the plurality of implants described throughout this specification.

The above described overlying implants facilitate placement of implants at adjacent spine levels by permitting the extensions to overlap and thus the extensions require less space on the sides of the spinous processes. In addition, where a rigid connection is formed between overlapping extensions, the rigidity of the overall spinal construct of multiple implants is increases. In the above described overlying implants, opposing surfaces of overlapping extensions may include pads, hooks, pins, teeth, bristles, surface roughness, adhesive, holes, loops, screws, bolts, and/or other features that permit one extension to grip another.

Referring to FIGS. **31-34**, an implant **1600** includes a spacer **1602** and extensions **1604**. As best seen in FIG. **32**, the spacer **1602** is shaped to provide superior and inferior voids or openings **1602**V. The voids or openings **1602**V are similar to the openings described throughout the application. The extensions **1604** include medially facing spikes **1606** for engaging the vertebrae. The spacer **1602** has a length **1608** extending medially-laterally and a height **1610** extending superiorly-inferiorly. A cylindrical path **1612** extends through the spacer **1602** along its length. The cylindrical path **1612** opens posteriorly through a slot **1614**. A draw bolt **1616** has a spherical tip **1618** at a first end and a cylindrical threaded portion **1620** at a second, opposite end. The tip **1618** and threaded portion are connected by a neck **1622**. The extensions **1604** include threaded bores **1624** formed through the extensions **1604** in an anterior-posterior direction. The implant **1600** is assembled by threading the draw bolt **1616** into the extensions **1604** with the tip **1618** projecting anteriorly. The tip is slidingly engaged with the path **1612** in the spacer **1602** with the neck projecting through the slot **1614**. As can be appreciated with reference to FIG. **32**, the spherical tip **1618** is shown in the cylindrical path **1612**. Moreover, the neck **1622** is shown extending from the tip **1618** trough the slot **1614**.

In use, the spacer **1602** is placed between adjacent spinous processes and the extensions **1604** are engaged with the spacer **1602**. Alternatively, one or both extensions **1604** may be preassembled to the spacer before the spacer **1602** is inserted between adjacent spinous processes. The extensions **1604** are pressed together to engage the spikes **1606** with the spinous processes. The fit of the spherical tip **1618** of the draw bolt **1616** within the cylindrical path **1612** permits the extensions **1604** to be angled relative to the spacer **1602**. If the neck **1622** of the draw bolt **1616** fits closely within the slot **1614**, the extensions are constrained to angulate medially-laterally. If the neck **1622** of the draw bolt **1616** fits loosely within the slot **1614**, the extensions may angle both medially-laterally and superiorly-inferiorly. The angulation of the extensions permits them to adjust to the angle of the underlying bone. Each draw bolt **1616** is then rotated to move the corresponding extension **1604** toward the spacer **1602** until the extension **1604** abuts the spacer **1602**. Further rotation of the draw bolt presses the extension **1604** and spacer **1602** together to lock their relative positions.

In the illustrative example of FIGS. **31-34**, the extensions **1604** are flared outwardly at an inferior portion **1626**. In particular, and perhaps best seen in FIG. **31** in one exemplary embodiment, a first of the extensions **1604** may be considered to have a first planar surface **1604'** defined by the superior portion **1604S**. Further, the first of the extensions **1604** may be considered to have a second planar surface **1604"** defined by the inferior portion **16041**. A second of the extensions **1604** similarly may be considered to have a third planar surface **1604'"** and a corresponding fourth planar surface **1604""**. As can be appreciated by FIG. **31**, the first planar surface **1604'** and the second planar surface **1604"** are non-coplanar with each other. Similarly, the third planar surface **1604'"** and the fourth planar surface **1604""** are non-coplanar with each other. The outward flare directs the superior spikes outwardly and inwardly to accommodate a small or missing spinous process such as, for example, on the sacrum of a patient. The inferior portion may include one or more holes **1628** to receive screws **1630** that seat on the inferior portion and engage the inferior vertebra, such as, for example, the sacrum to more positively engage the inferior vertebra.

Referring to FIGS. **35-36**, an implant **1700** includes a first half **1702** and a second half **1704**. Each half **1702**, **1704** includes both a portion of a spacer **1706** and an extension **1708**. At least one of the spacer portions includes a medial-lateral slot **1710** and at least one of the extensions includes a superior-inferior slot **1712**. When assembled, the slots **1710**, **1712** overlie one another and a bolt **1714** extends through the slots to pin the first and second halves **1702**, **1704** together. A nut **1716** captures the bolt **1714**. The superior-inferior slot **1712** permits adjustment of the superior-inferior spacing between the spacer portions **1706** to vary the spacer height as can be seen by comparing FIGS. **35** and **36**. The medial-lateral slot **1710** permits adjustment of the medial-lateral spacing between the extensions **1708** to allow the extensions to be engaged with the spinous processes. When the desired spacings are achieved, the nut **1716** is tightened to compress the assembly together and simultaneously lock both of the spacings. In the illustrative example of FIGS. **35-36**, the inferior portion **1718** of at least one of the extensions has angled spikes arranged to engage an inferior vertebra with a small or missing spinous process such as the sacrum. In this example, one extension has spikes superiorly and inferiorly while the other extension is smooth to ease height adjustment.

Referring to FIGS. **37-38**, a modular implant **1800** includes a cross bar **1802** and extensions **1804**. Each extension **1804** includes a spiked pad **1806** with spikes **1807** projecting outwardly from the spiked pad, a spinous process shelf **1808** projecting outwardly in the same direction as the spikes **1807**, and an extension rod **1810**. The spiked pad **1806** has a width **1811** and the spinous process shelf **1808** has a width **1812**. In the illustrative example of FIGS. **37-38**, the spinous process shelf width **1812** is less than the spiked pad width **1811** to permit assembly of aligned, opposing extensions **1804** with spinous process shelves **1808** lying side-by-side in the same plane. Further, in the illustrative example of FIGS. **37-38**, the spinous process shelf width **1812** is less than one-half the spiked pad width **1811** to permit assembly of aligned, opposing extensions **1804** with spinous process shelves **1808** lying side-by-side in the same plane with a gap between them to permit tissue growth between the shelves. A joint cylinder **1813** includes a threaded axial bore **1814** along the longitudinal axis of the joint cylinder and multiple transverse bores transverse to the axial bore **1814** and extending through the joint cylinder **1813** sidewall. The transverse bores include an inboard transverse bore **1816** and outboard transverse bores **1818** on either side of the inboard transverse bore **1816**. The inboard transverse bore **1816** is sized to receive the cross bar **1802** in close fitting sliding relationship. The outboard transverse bores **1818** are sized to receive the extension rods **1810** loosely to permit the extension rods **1810** to toggle in the bores.

The modular implant **1800** is assembled by placing a joint cylinder **1813** on each end of a cross bar **1802** with the cross bar **1802** extending through the inboard bore **1816** of each joint cylinder **1813**. Two cross-drilled balls **1820** are next inserted into the axial bore **1814** of each joint cylinder **1813** and aligned with the outboard bores **1818**. Two extensions are mounted to each joint cylinder **1813** by inserting the extension rod **1810** of each extension into the outboard bores **1818** and through the corresponding cross-drilled ball **1820**. The cross-drilled balls **1820** are sized to fit closely within the axial bore **1814** and touch the cross bar **1802**. Once assembled, the modular implant **1800** can be adjusted by sliding and rotating the joint cylinders **1813** relative to the cross bar **1802** and sliding, rotating, and toggling the extension rods **1810** relative to the joint cylinders **1813**. When the desired adjustment is achieved, a set screw **1822** is inserted into at least one side of each axial bore **1814** and tightened to compress the cross-drilled balls **1820**, extension rods **1810**, and cross bar **1802** tightly together and thereby lock the adjustment. In the illustrative example of FIGS. **37-38**, the extensions **1804** are all identical, the cross-drilled balls are identical, and the joint cylinders are identical so that an implant can be assembled from a few basic components simplifying assembly and reducing inventory costs. However, if desired, a wider variety of component shapes and sizes may be provided to allow the modular implant to be tailored in various ways.

For example, in FIG. **39**, a double ended extension **1824** is provided having an extension rod **1826** extending superiorly and another extension rod **1828** extending inferiorly. By using the double ended extension **1824** as a joiner, the modular implant can be assembled to treat multiple adjacent spinal levels. In the illustrative example of FIG. **39**, the implant has been assembled using the double ended extension **1824** to engage three adjacent spinous processes and thus treat two adjacent spinal levels. However, any number of extensions can be assembled in this manner to treat any number of spinal levels. In addition to components, such as the double ended extension **1824**, to allow treatment of multiple levels, component may be provided that are adapted to particular bone geometries. For example, extensions having flared spiked pads, extra long spikes, and screw receiving holes similar to the examples of FIGS. **31-36** may be provided, for example, to permit assembly of an implant with an inferior portion suitable for gripping a vertebra with a small or missing spinous process, such as, for example, the sacrum.

Referring to FIG. **40**, an implant **1900** similar to that of FIGS. **37-39** is illustrated. The implant **1900** includes extensions **1902** having flattened spikes **1904**.

Referring to FIGS. **41-42**, an implant **1950** similar to those of FIGS. **37-40** is illustrated. However, in the illustrative example of FIGS. **41-42**, the extension **1952** includes an extension rod **1954** and spiked pads **1956** mounted for translation and rotation along the extension rod **1954**. Each spiked pad **1956** is mounted to an extension rod **1954** with a cross drilled sphere **1958** and a split yoke **1960**. The cross drilled sphere **1958** is slipped over an end of the extension rod **1954** and a first end of the split yoke **1960** is snapped over the cross-drilled sphere **1958** so that the cross-drilled sphere **1958** rides in a groove **1962** inside the split yoke **1960**. A second end of the split yoke **1960** is mounted in a bore **1964** in the spiked pad **1956**. The outer surface of the split yoke **1960** includes a tapered portion **1966** adjacent the mounting of the split yoke **1960** in the bore **1964**. The extension rod **1954** is mounted to the cross bar **1968** with joint cylinders **1970** similar to those of the examples of FIGS. **37-40**. When the joint cylinders **1970** are slid medially to engage the spiked pads **1956** with the spinous processes, each spiked pad **1956** is pressed outwardly toward the extension rod **1954**. The edges of the bore **1964** slide against the tapered surface **1966** and squeeze the split yoke **1960** closed so that it is compressed around the cross-drilled sphere **1958** and extension rod **1954** and locks the relative position of the spiked pad **1956** and extension rod **1954**. Referring to FIG. **43**, an implant **2000** includes spiked pads **2002**, extension rods **2004**, and cross bars **2006**. Each spiked pad **2002** has a spiked face **2008** and an opposite side **2010** having a least one spherical socket **2012** formed in it. In the illustrative example of FIG. **43**, each spiked pad **2002** has two spherical sockets **2012** to permit multi-level constructs as described below. Each extension rod **2004** includes a spherical ball end **2014** formed at each of its ends. The cross bar **2006** includes a longitudinal slot **2016** dividing the cross bar **2006** into two cantilevered beams **2018** joined at a first end **2020** and threaded at a second end **2022** for receiving a retaining nut **2024**. The implant **2000** is assembled by snapping a spiked pad **2002** onto each end or each of two extension rods **2004** and placing the extension rods **2004** in the slot of the cross bar **2006**. The nut **2024** is threaded onto the end of the extension rod and threadingly advanced to move the extension rods **2004** closer together and compress the spiked pads against the spinous processes. Additional spinal levels may be accommodated by snapping additional extension rods into the second holes of spiked pads, snapping additional spiked pads **2002** to the free end of the additional rods and compressing the additional assembly with an additional cross bar and nut as shown in FIG. **43**.

Referring to FIG. **44**, an implant **2100** includes a spacer **2102** including a superior bar **2104**, and inferior bar **2106**, and anterior bar **2108**, and a posterior bar **2110**. Gaps **2112**, or fenestrations, between the bars permit tissue growth between the bars and receive extension rods **2114** extending from spiked pads **2116**. In the illustrative example of FIG. **44**, four independent spiked pads **2116** are provided. Two of the spiked pads **2116** are supported by insertion of their extension rods **2114** between posterior surfaces **2118** of the superior and inferior bars and an anterior surface **2120** of the posterior bar. Two of the spike pads **2116** are supported by insertion of their extension rods **2114** between anterior surfaces **2122** of the superior and inferior bars and a posterior surface **2124** of the anterior bar. A bolt **2126** extends from the anterior bar **2108** through a bore **2128** in the posterior bar **2110** and is secured with a nut **2130**. Tightening the nut **2130** compresses the bars and extension posts together to lock the position of the spiked pads **2116**. Loosening the nut **2130** allows independent adjustment of each spiked pad **2116** medially-laterally **2132**, superiorly-inferiorly **2134**, angularly **2136**, and rotationally **2138**.

Referring to FIGS. **45-47**, a portion of an implant **2200** is shown to illustrate a mechanism for providing an adjustable height spacer **2202** having a superior bar **2204** and an inferior bar **2206**. The **2204**, **2206** bars include longitudinal serrations on their anterior sides **2208** and posterior sides **2210**. The bars **2204**, **2206** are received in a first superiorly-inferiorly elongated slot **2212** formed in an extension **2214**. The first slot **2212** includes anterior serrations **2216** engageable with the anterior serrations **2208** of the bars **2204**, **2206** to support the bars in a selected superior-inferior position. A second superiorly-inferiorly elongated slot **2218** is formed in the extension **2214** transverse to the first slot **2212**. The second slot **2218** includes opposed hemi-cylindrical threaded concavities **2220** formed in its sidewalls and directed toward the first slot **2212**. The second slot **2218** receives a lock block **2222** in sliding relationship toward the first slot **2212** and the threaded concavities **2220** receive a lock screw **2224** in threaded relationship. The lock block **2222** includes anterior facing serrations **2223** engageable with the posterior serrations **2210** of the bars **2204**, **2206**. In use, the bars **2204**, **2206** and extension **2214** are engaged with the bars **2204**, **2206** received in the first slot **2212**. The bars **2204**, **2206** are adjusted superiorly-inferiorly and medially-laterally within the first slot **2212** to a desired position relative to the extension **2214**. The lock screw **2224** is then rotated causing the lock screw to advance toward the first slot **2212** and drive the lock block **2222** toward the first slot **2212**. The lock block **2222** presses against the bars **2204**, **2206** causing the serrations of the lock block **2222**, bars **2204** and **2206**, and first slot **2212** to engage and lock the desired relative position between the extension **2214** and rods **2204**, **2206**. Alternatively, the serrations may be omitted and locking accomplished by frictional engagement.

The mechanism of FIG. **44** may be substituted in the preceding examples. For example the mechanism of FIG. **44** may be substituted in the implant **100** of FIGS. **1-9** to provide implant **100** with an adjustable height spacer.

Referring to FIGS. **48-49**, an implant **2300** suitable for treating multiple spinal levels includes multiple spacers **2302**, **2304** and first and second unitary, multilevel extensions **2306**. Each spacer includes an elongated, hollow, body having a non-circular cross-sectional shape (FIG. **49**). Each spacer further includes at each end a first slot **2310** formed through its sidewall and extending a short distance longitudinally toward the opposite end of the spacer to an inboard end of the first slot. Each spacer further includes a second slot (not shown) formed through its sidewall and extending circumferentially from the inboard end of each first slot **2310** to a third slot **2312**. In the illustrative example of FIGS. **48-49**, the first slot **2310** is formed in a relatively narrow side **2314** of the non-circular spacer and the third slot **2312** is formed in a relatively wide side **2316** of the non-circular spacer, the sides being approximately ninety degrees apart (FIG. **49**). A cylindrical nut **2318** is provided to fit inside the hollow body at each end of each spacer **2302**. The nut **2318** includes a threaded cross-bore **2320**. The extensions **2306** each include a generally flat, medially facing surface **2322** having multiple spiked regions **2324**, **2326**, **2328** and a flange **2330** extending laterally from the extension **2306**. Each flange **2330** includes superiorly-inferiorly elongated holes **2332** extending through the flange **2330** from a posterior surface **2334** to an anterior surface **2336**. Lock bolts **2338** are provided to join the extensions **2306** to the spacers **2302**, **2304**. In use, the lock bolts **2338** are extended through the flanges **2330** and a nut **2318** is loosely threaded onto each bolt. The spacers **2302**, **2304** are placed between adjacent spinous processes initially with their narrow dimension opposing the spinous processes as shown with the superior spacer **2302** in FIG. **49**. The extensions **2306** are positioned on opposite sides of the spinous processes and the nuts **2318** are slipped into the hollow interior of the spacers with the bolts **2338** sliding through the first slot as shown with the superior spacer **2302** in FIG. **49**. The elongated holes **2332** in the flanges **2330** permits superior-inferior adjustment of the spacers **2302**, **2304** relative to the extensions **2306**. The spacers **2302**, **2304** are then rotated to position their wide dimension opposing the spinous processes as shown with the inferior spacer **2304** in FIG. **49**. This rotation may be accomplished for example by engaging an instrument with the first slit to apply a torque to the spacer. Rotation of the spacers **2302**, **2304** causes the spinous processes to move apart as the wide dimension of the spacers is rotated between the spinous processes. As the spacers rotate, the bolts **2338** slide through the second slot (not shown) until they are aligned with the third slot **2312** in the spacer. The extensions **2306** are now compressed medially to engage the spikes with the spinous processes. The bolts **2338** slide within the third slot **2312** during compression. Once the bolts move inward of the second slots, the spacers are prevented from rotating back by the bolts **2338** abutting the sides of the third slot **2312**. The bolts **2338** are tightened to lock the position of the spacers **2302**, **2304** relative to the extensions **2306**.

While a specific illustrative example and use of implant **2300** has been shown and described, it is to be understood that implant **2300** can be assembled in any order. For example, the nuts **2318** may first be slipped into the spacers **2302**, **2304**, the spacers placed between the spinous processes in a desired final position, the extensions **2306** compressed medially into the spinous processes, and then the bolts **2338** inserted and tightened. Likewise, while implant **2300** has been shown to treat two spinal levels, it can be readily modified to treat one, three, four, five or any number of spinal levels. Likewise, while the spacers **2302**, **2304** have been shown with two different dimensions and being rotated to facilitate distraction of the spinous processes, the spacers **2302**, **2304** may be inserted without rotation and may have, for example, a single slot for receiving bolts **2338**.

Referring to FIGS. **50-51**, an implant **2400**, similar to that of FIGS. **1-9**, further includes a separate member **2402**, **2403** engageable with the spacer **2404** to be positioned between adjacent vertebrae. The separate member **2402**, **2403** may be used to provide additional structural support, to provide bone growth promoting material, or both. The member **2402**, **2403** may be made of metal, plastic, bone, ceramic, or any other suitable material. For example, the member **2402**, **2403** may be a structural bone graft that both contributes to the support of the spacing between adjacent vertebrae and provides bone growth promoting minerals and scaffolding to the surgical site. Also, for example, the member **2402**, **2403** may be coupled to the spacer to provide additional material anterior of the spacer. The member **2402**, **2403** may be sized smaller (superiorly-inferiorly) than the spacer **2404** so that it bears little, if any of the load of adjacent vertebrae. Or, the member **2402**, **2403** may be sized similarly to the spacer **2404** so that it shares the load of adjacent vertebrae. Or, the member **2402**, **2403** may be sized larger than the spacer **2404** so that it bears most, or all, of the load of adjacent vertebrae. For, example, the member **2402**, **2403** may be a structural allograft bone member that is sized slightly larger than the spacer **2404** to bear the load of adjacent vertebrae to encourage bone growth. However, if the member **2402**, **2403** were to resorb or subside, the adjacent vertebrae would then be safely supported by the spacer **2404**. Referring to FIG. **50**, the member **2402** is generally in the form of a plate-like body having a superior surface **2406**, an inferior surface **2408**, a convex anterior surface **2410**, and generally flat posterior surface **2412** and a posteriorly projecting connecting member **2414**. The connecting member includes a base **2416** joined to the posterior surface **2412** tapering to a neck **2418** connected to an expanded engagement end **2420**. The engagement end **2420** has a cross-sectional shape corresponding to the cross sectional shape of the interior **2422** of the spacer **2404**. In use, the member **2402** is coupled to the spacer **2404** by sliding the engagement end **2420** into the interior **2422** of the spacer **2404**, with the neck **2418** sliding within an anteriorly opening slot **2424** of the spacer **2404**. While the member **2402** is shown in use to augment the anterior side of the spacer **2404**, it may be configured to augment any one or multiple sides of the spacer **2404**.

Referring to FIG. **51**, the member **2403** is similar to member **2402** of FIG. **50** except that instead of engaging the interior of the spacer **2404** it engages the exterior of the spacer **2404** with a ring-shaped engagement member **2450** that slides over the spacer **2404**. In addition, the member **2403** includes chamfers **2452** at each end to provide clearance for portions of the vertebrae such as, for example, the facet joints.

Referring to FIGS. **52-53**, a set **2600** of instruments for distracting or compressing adjacent vertebrae away from or toward one another and for compressing implant extensions medially toward the spinous processes is illustrated. The set **2600** includes a pair of Kocher-style bone clamps **2602** having a scissor-like action with a handle end **2604** and a working end **2606** terminating in bone gripping tips **2608**. A Caspar-style compressor/distracter **2610** includes arms **2612** joined by a rack **2614** extending from one arm and engaging a gear assembly **2616** mounted on another arm. A knob **2618** is responsive to rotation to rotate a pinion (not shown) relative to the rack **2614** and cause the rack to translate. Rotation of the knob **2618** in a first direction causes the arms **2612** to move away from one another and rotation of the knob **2618** in an opposite direction causes the arms **2612** to move toward one another. The arms **2612** terminate in arm clamps **2620** able to receive the Kocher-style bone clamps **2602**. The set **2600** further includes implant compressors **2624** having a scissor-like action with a handle end **2626** and a working end **2628** terminating in implant gripping tips **2630**.

In use, an implant **100** is positioned with spacer between adjacent spinous processes **2650** and extensions on each side of the spinous processes **2650**. The bone clamps **2602** are clamped to the vertebrae. For example, they are clamped to adjacent spinous processes **2650**. The arm clamps **2620** of the compressor/distracter are attached to the bone clamps **2602**. The knob **2618** is then rotated to compress or distract the arms **2612**, and by extension the bone clamps **2602**, until the vertebrae are in a desired relative spacing. The implant compressors **2624** are then engaged with the implant **100** and compressed to cause the extensions of the implant to engage the spinous processes to secure the desired spacing between the vertebrae.

Referring to FIGS. **54-56**, an alternative tip configuration **2700** for the implant compressor **2624** of FIGS. **52-53** is illustrated. The tips **2700** include extensions **2702** having a profile contoured to generally match the posterior profile of the implant extensions **2704** to distribute compressive forces over the surface of the implant extensions **2704**. The compressor extensions **2702** taper toward their superior and inferior aspects **2706**, **2708** to minimize the space needed superiorly and inferiorly for tip insertion and to decrease the amount of the surgical view that is obstructed by the tips. Where the implant includes a set screw bore **2710**, the extension **2702** and arm **2710** may include a relieved portion **2712** aligned with the set screw bore **2710** to permit driving a set screw in the bore **2710**.

Referring to FIG. **57**, an implant inserter **2800** is useful for inserting an implant **100** similar to that of FIGS. **1-9** in a direct posterior approach. The inserter **2800** includes a first arm **2802** and a second arm **2804** joined in a scissor-like arrangement and having a handle **2806** end and a working end **2808**. The working end of each arm **2802**, **2804** includes a clamping face **2810**, **2812** movable toward and away from one another in response to movement of the working end of the arms toward and away from one another. The clamping faces **2810**, **2812** are operable to clamp, and thereby grip, the first extension **126** of the implant **100**. The first arm **2802** includes a foot **2814** projecting medially from first end **2816** near the clamping faces **2810**, **2812** to a second end **2818** spaced from the clamping faces **2810**, **2812**. The foot **2814** is positionable over the spacer **102** when the clamping faces **2810**, **2812** are in clamping engagement with the first extension **126**. A slot **2820** is formed near the second end **2818** of the foot **2814** and extends posteriorly from an anterior edge **2822** of the foot **2814**. The slot **2820** is sized to receive the second extension **128**.

In use, the second extension **128** is placed on the spacer **102** and the inserter **2800** is engaged with the implant by positioning the foot over the spacer **102** such that the slot **2820** receives the second extension **128** and the clamping faces **2810**, **2812** are on opposite sides of the first extension **126**. The inserter handles **2806** are operated to clamp the first extension **126**. Thus clamped, the first and second extensions **126**, **128** are held securely in a predetermined spaced relationship. If desired, the set screw **130** (FIG. **3**) may be inserted and tightened to further secure the second extension **128** in anticipation of eventual removal of the inserter **2800**. A relief cut **2824** through the foot **2814** posteriorly-to-anteriorly is aligned with the set screw bore to facilitate operation of the set screw while the implant **100** is engaged with the inserter. The inserter **2800** may be used to insert the implant **100** in a direct posterior-to-anterior direction between adjacent spinous processes. The superior and inferior aspects **2826**, **2828** of the loot **2814** may be relieved to avoid tissue impingement on the foot **2814** and to improve visualization.

Referring to FIG. **58**, a rasp **2900** is provided for rasping adjacent tissues, for example, for removing tissue between adjacent spinous processes in preparation for insertion of the implant **100**. The rasp **2900** includes head **2901** having a conical tip **2902** to aid insertion and teeth **2904**, insertion and removal of the rasp head **2901** along its longitudinal axis and rotation of the rasp head **2901** about its longitudinal axis **2906** will remove abutting tissue. In the case of its use to prepare adjacent spinous processes, an angled handle **2908**, for example forming an angle **2910** in the range of 135 to 45 degrees, more preferably in the range of 120 to 60 degrees, more preferably at about 90 degrees, is useful to position the head **2901** between the spinous processes and rotate it back and forth about its axis to abrade tissue. The teeth **2904** are angled toward the handle **2908** to ease the initial insertion of the head **2901**. The angled teeth **2904** are less prone to snagging upon insertion.

Although examples of a spinous process implant and associated instruments and techniques have been described and illustrated in detail, it is to be understood that the same is intended by way of illustration and example only and is not to be taken by way of limitation. Accordingly, variations in and modifications to the spinous process implant, instruments, and technique will be apparent to those of ordinary skill in the art, and the following claims are intended to cover all such modifications and equivalents.

What is claimed is:

1. An implant for placement between spinous processes of adjacent vertebrae of a spine, the implant comprising:

a spacer with a first end, a second end, and a longitudinal axis extending from the first end to the second end, the spacer having a sidewall extending longitudinally and having superior and inferior surfaces operable to abut the spinous processes and maintain the spinous processes in spaced apart relationship, the superior and inferior surfaces being spaced apart a distance corresponding to a predetermined minimum spacing between the spinous processes, the spacer having a length extending medially-laterally and a height extending superiorly-inferiorly such that the spacer further includes:

a cylindrical path extending along the length, the cylindrical path defining a cylinder with a circular cross-sectional shape,

a slot opening posteriorly on the cylindrical path, and

a bolt including a spherical tip slidingly disposed within the cylindrical path and a threaded shaft extending from the slot; and

a first extension projecting from the spacer transverse to the longitudinal axis to lie generally alongside the spinous processes of adjacent vertebrae, wherein a superior portion of the first extension forms a first surface facing a superior spinous process and an inferior portion of the first extension forms a second surface facing an inferior spinous process such that the second surface is non-coplanar with the first surface, the first extension being engageable with the spinous processes to limit the maximum spacing between the spinous processes, the first extension including a threaded bore, such that the first extension is connected to the spacer by threading the bolt into the threaded bore.

2. The implant of claim **1**, further comprising at least one fastener on the inferior portion of the first extension wherein the second surface of the inferior portion is adapted to direct the at least one fastener into bone.

3. The implant of claim **1**, further comprising at least one fastener and wherein the second surface of the inferior portion comprises a bore such that the at least one fastener is removably coupled to the bore and adapted to engage bone.

4. The implant of claim **3**, wherein the fastener comprises a bone screw.

5. The implant of claim **4**, wherein the bone screw is adapted to engage the sacrum.

6. The implant of claim **1**, further comprising a plurality of fasteners wherein at least one of the plurality of fasteners resides on the second surface of the inferior portion and at least one of the plurality of fasteners resides on the first surface of the superior portion such that the at least one fastener residing on the second surface is angled and non-parallel with the at least one fastener residing on the first planar surface, and wherein the first surface and the second surface are adapted to direct the plurality of fasteners into bone.

7. The implant of claim **2**, wherein the at least one fastener is adjustable angularly relative to the second surface of the inferior portion of the first extension such that the at least one fastener is non-normal with the second surface of the inferior portion.

8. The implant of claim **1**, wherein the superior portion and the inferior portions are offset anteriorly-posteriorly relative to one another to define a generally "Z"-shaped offset such that the inferior portion extends further posteriorly than the superior portion extends anteriorly.

9. The implant of claim **1**, further comprising a second extension opposing the first extension wherein the second extension is adapted to lie generally alongside the spinous processes of adjacent vertebrae on an opposite side of the first extension.

10. The implant of claim **9**, wherein the second extension directly engages the spacer and is translated over the spacer toward the first extension.

11. The implant of claim **9**, wherein the second extension comprises a superior portion forming a third surface and an inferior portion forming a fourth surface such that the fourth surface is non-coplanar with the third surface.

12. The implant of claim **1**, wherein the second surface is substantially perpendicular to the longitudinal axis.

13. The implant of claim **1**, wherein the first surface is substantially perpendicular to the longitudinal axis.

14. The implant of claim **1**, wherein the superior portion and the inferior portion are coupled by a portion of the first extension extending between the superior portion and the inferior portion.

15. An implant for placement between spinous processes of adjacent vertebrae of a spine, the implant comprising:

a spacer with a first end, a second end, and a longitudinal axis extending from the first end to the second end, the spacer having a sidewall extending longitudinally and having superior and inferior surfaces operable to abut the spinous processes and maintain the spinous processes in a spaced apart relationship, at least a first superior opening in the spacer and at least a first inferior opening in the spacer the superior and inferior surfaces being spaced apart a distance corresponding to a predetermined minimum spacing between the spinous processes, the spacer further including:

a cylindrical path extending along the length, the cylindrical path defining a cylinder with a circular cross-sectional shape,

a slot opening posteriorly on the cylindrical path, and

a bolt including a spherical tip slidingly disposed within the cylindrical path and a threaded shaft extending from the slot;

a first extension attached to the spacer, the first extension including a threaded bore, such that the first extension is connected to the spacer by threading the bolt into the threaded bore.

16. The implant of claim **15**, further comprising a second extension attached to the spacer and engageable with the spinous processes to limit a maximum spacing between the spinous processes, the first and second extensions each including a superior portion and an inferior portion, the superior portion of the first extension defining a first plane and the inferior portion of the first extension defining a second plane non-coplanar to the first plane, the superior portion of the second extension defining a third plane and the inferior portion of the second extension defining a fourth plane non-coplanar to the third plane, wherein the inferior portion of the second extension diverges from the inferior portion of the first extension in an inferior direction.

17. The implant of claim **15**, further comprising a second extension attached to the spacer, the first and second extensions each including a superior portion and an inferior portion, the inferior portions of the first and second extensions each including at least one fastener, wherein the inferior portions are adapted to direct the at least one fastener into bone.

18. The implant of claim **15**, wherein at least one of the first superior opening and the first inferior opening includes a transverse passageway through the spacer.

19. The implant of claim **18**, wherein the spacer is substantially hollow and the transverse passageway is formed by the hollow spacer.

20. The implant of claim **17**, wherein the at least one fastener on the inferior portion of the first extension and the at least one fastener on the inferior portion of the second extension converge.

21. The implant of claim **15**, further comprising a second extension attached to the spacer, the first and second extensions each including an inferior portion, wherein the inferior portions of the first and second extension are adapted to engage a sacrum.

22. The implant of claim **15**, further comprising a second extension attached to the spacer, the first and second extensions each including an inferior portion, wherein the inferior portions of the first and second extensions are adapted to engage a bone having a small spinous process relative to an adjacent spinous process.

23. The implant of claim **15**, further comprising a second extension attached to the spacer, the first and second extensions each including an inferior portion, wherein the inferior portions of the first and second extensions are adapted to engage a lamina.

24. A method of treating spine disease comprising:

providing a spacer with a first end, a second end, and a longitudinal axis extending from the first end to the second end, the spacer having a sidewall extending longitudinally and having superior and inferior surfaces operable to abut adjacent spinous processes and maintain the spinous processes in a spaced apart relationship, the superior and inferior surfaces being spaced apart a distance corresponding to a predetermined minimum spacing between the spinous processes; a first extension projecting from the spacer transverse to the longitudinal axis to lie generally alongside the spinous processes of adjacent vertebrae, the first extension having a threaded bore, a superior portion and an inferior portion where part of the inferior portion is angled and non-parallel with respect to the superior portion, the first extension being engageable with the spinous processes to limit the maximum spacing between the spinous processes; and a second extension to lie generally alongside the spinous processes of adjacent vertebrae on a side opposite the first extension, the second extension having a superior portion and an inferior portion where part of the inferior portion is angled and non-parallel with respect to the superior portion, the second extension being engageable with the spinous processes to limit the maximum spacing between the spinous processes, the spacer having a length extending medially-laterally and a height extending superiorly-inferiorly such that the spacer further includes:

a cylindrical path extending along the length, the cylindrical path defining a cylinder with a circular cross-sectional shape,

a slot opening posteriorly on the cylindrical path, and

a bolt including a spherical tip slidingly disposed within the cylindrical path and a threaded shaft extending from the slot;

inserting the spacer between spinous processes of adjacent vertebrae to provide both an extension stop and a flexion stop;

engaging the second extension to the spacer;

threading the bolt into the threaded bore;

translating the second extension axially towards the first extension so as to slide the second extension toward the first extension so the first and second extensions engage with the spinous processes to fix the spacer to the spinous processes; and

securing the second extension at a desired location along the spacer relative to the first extension.

25. The method of claim **24**, wherein the spacer further comprises a plurality of fasteners wherein at least one of the plurality of fasteners resides on the part of the inferior portion of the first extension and at least another of the plurality of fasteners resides on the part of the inferior portion of the second extension, and wherein the translating step comprises engaging the at least one and the at least another of the plurality of fasteners with a sacrum.

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